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15 March 1995

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MHI's Nagoya Aircraft Works To Shift Space/Defense Technology

94FE0900A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 29 Aug 94 p 22

[FBIS Translated Text] Mitsubishi Heavy Industries' (MHI) Nagoya Aircraft Works (Meiko) began moving in full gear to strengthen its commercial division. The company has established a new section dedicated to new product development and business. This section will handle new product development and promotion of sales for the commercial field. In its effort to open up a new market, the company shifted defense and space technologies accumulated during the past years to private sector use. Thus far, more than 16 new products have been developed. At present, of the company's annual production amount of ¥220 billion, only a few billion yen came from non-defense products. The company's goal is to increase non-defense production ratio to reach around 10 percent, or ¥20 billion plus a year.

The MHI is forced to make this move because of the continuing decline in defense orders caused by defense cutbacks. By shifting its production from defense to non-military use, the company hopes to maintain its production base and to expand its application technology capabilities. In the course of reviewing its organizational structure, the company recently established a new-product development and business section consisting of 15 staff members. This section has already begun its operation. Its effort to develop new products in the six fields targeted, e.g., airport-related field, wind tunnels, radio waves, simulators, control systems, composite materials application products, already has resulted in groups of commercial products which incorporate aerospace element technologies.

Recently, MHI has received an order of about ¥2 billion for one of these products, Japan's first "electronic sterilization system," from the Hogi Medical Co., a company which manufactures and sells to hospitals sterilized medical surgical gowns. This system is used in sterilizing medical goods and tools just before they are to be discarded. This product was manufactured by using a radio wave application technology, the "accelerator." Through acceleration of electrons, it generates high power and high energy which are utilized in sterilization. In addition to its use for medical products, the company is considering the possible use of this system in sterilizing vials and food package wrappers. Also considered is devoting part of the section's effort to expand the market for the system. Other new products, including the simulator, have already been delivered while inquiries continue to come in.

NASDA To Order KHI, Shimadzu Corp. for Astronaut Training Facility Construction

94FE0900B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 29 Aug 94 p 22

[FBIS Translated Text] The National Space Development Agency (NASDA; Mr. Masato Yamano, Director) revealed that the Kawasaki Heavy Industries (Mr. Hiroshi Ohba, president) and Shimadzu Corporation (Mr. Kikuo Fujiwara, president) have been awarded a contract for construction of the astronaut training facility at Tsukuba Space Center's SSIP (space station center). Kawasaki will be in charge of an overall arrangement as well as the building of a closed environmental adaptation facility while Shimadzu Corporation will handle a low-pressure adaptation training facility. The total amount of the order is estimated at approximately ¥3 billion, with a delivery date set for December 1995. This new construction is expected to further improve Japan's astronaut training setup.

Established at Tsukuba at Total Cost of ¥3 Billion

These facilities will be used for closed as well as low-pressure environmental adaptation training essential to the astronaut training program as well as to the development of required technologies. The closed environmental adaptation training will allow astronauts prior to actual flight to experience mental and physical stress under the simulated conditions, namely, physical and social environment of a space station's pressurized cabin, so that they will know how to deal with them in actual flight.

Moreover, since the program will provide astronauts with the opportunity to train together with overseas astronauts, they will also learn how to coexist under, and adapt to, a cultural environment alien to them. The aims of the low-pressure environmental adaptation training are for astronauts to acquire knowledge and familiarize with procedures to ensure their safety and to experience and master the survival skill under the low-pressure environment.

Both facilities have a modular structure simulating a space station. The closed environmental adaptation training facility, consisting of experimental and living quarters, is equipped to handle a maximum of eight astronauts (two four-person teams) allowing them to live in an environment totally isolated from the outside world for a period of one month (a maximum of three months). During this period, astronauts will live within the module, carrying out work in space-station-simulated environment. At the same time, they will receive psychological and human engineering training.

The low-pressure environmental adaptation training facility, on the other hand, is designed to reduce atmospheric pressure so that the following types of training can be conducted:

(1) the training designed to familiarize astronauts with low-pressure environment and to teach a method of dealing with it;

(2) the training designed to teach a method of dealing with sudden fall in pressure inside the module; and

(3) environmental adaptation training wearing space clothing.

In coordination with the continuing development of spacecraft, including H-II rocket, NASDA plans to further strengthen the astronaut training system in terms of both software and hardware for Japan's hypothetical experimentation wing, "JEM," at the international manned space base, a project undertaken by joint international efforts.

MHI Signs Contract for Partial Production of B737X

94FE0900C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 26 Aug 94 p 18

[FBIS Translated Text] The Mitsubishi Heavy Industries (MHI) (Mr. Kentaro Aikawa, president) signed a contract with Boeing Corp. for partial production of the next medium-sized passenger aircraft B737X (140-seater scale) to be developed by Boeing. MHI will manufacture a flap of the main wing. The company is scheduled to begin production as early as 1995 at its Nagoya Aircraft Works (Nagoya City). If the number of planes which Boeing plans to produce is firm (20 planes a month), then MHI's annual sales figure will jump to a few billion yen.

B737X is a successor to the present B737; it aims for longer distance on continuous flight, improved fuel cost, and reduced noise level. Boeing will begin producing the planes in 1995, aiming for completion in 1997, followed by the inaugural flight. As for possible participation of Japanese companies other than MHI in the project, Kawasaki Heavy Industries, Fuji Heavy Industries, Japan Aircraft Mfg. Co., and Shin Meiwa Industry have come forward. Currently, these companies are separately negotiating with Boeing. MHI's contract, therefore, was the first to be signed.

JGC Corp. Starts Joint "Mission Assurance" Operation With VITRO

94FE0900D Tokyo NIKKAN KOGYO SHIMBUN in Japanese 25 Aug 94 p 10

[FBIS Translated Text] As a part of its space development activities, JGC Corporation has undertaken "Mission Assurance" operation in cooperation with Vitro, an American space-related engineering firm. JGC will be involved in safety and development assurance work, conducting satellite inspection at each stage of its life, beginning with design and manufacturing and continuing on to launching, operational control, and recovery. The company currently is submitting proposals to broadcasting and communication companies here in Japan as well as in Mexico and Korea.

The mission assurance work is not unlike a regular insurance work except that it is specifically related to space development. JGC Corporation possesses well-established project management and system technologies designed to execute oil refinery-, petrochemistry-, and energy-related projects. In order to apply these capabilities and functions to space-related fields as well, the company is participating in space development projects.

The mission assurance utilizes the company's management capability to assure safety and reliability, including quality control and assurance. The company is cooperating with Vitro in the areas of information gathering and task support.

For instance, in satellite production and operation, JGC will perform inspection at various stages, beginning with design, manufacturing, launching, space operation, various tests, and recovery, to assure safety and reliability of the satellite involved.

At present, the company is submitting proposals to broadcasting and telecommunication companies here in Japan as well as Mexico and Korea.

Since this business still has only a few application examples, the company expects that its pioneering effort to locate where needs are will ultimately pay off handsomely.

SJAC Forms Special Committees for Future International Joint Space Development

94FE0900E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 23 Aug 94 p 18

[FBIS Translated Text] The Society of Japanese Aerospace Companies, Inc. (SJAC) revealed that it will form four special committees designed to conduct research and surveys on important areas of the space industrial field. The committees are to begin their activities soon. They are designated as "Committee on International Joint Maintenance of Aircraft Equipment," "Committee on Promotion and Study of High Reynolds-Number Aerodynamic Test Engineering Research," "Committee on Survey of Commissioned Research in Next Generation Space Technology," and "Committee on Survey of Trend for Commercialization of Space Industry." Each committee, served by experts with scholarly knowledge and experience as well as by representatives from the industry, will hold meetings regularly and put together results of their studies by the end of 1994 at the earliest. SJAC expects that these technical investigations dealing with important aerospace problems will make industrial technological base more substantial.

"Committee on International Joint Maintenance of Aircraft-Mounted Equipment" (Chairman: Mr. Minoru Azumaguchi, Professor Emeritus of the University of Tokyo) is designed to deal with increased requests from equipment manufacturers for international joint development to reduce the number of developments and developmental risks as equipment becomes increasingly high tech and diversified. In the aircraft field, although international joint development is an active part of both engine and frame divisions, this is not necessarily true of machineries as they cover a wide area and their unit costs are not as high as those of engines and frames. In addition, no centralized mechanism for international business exchange exists. The committee will explore the

means for promoting international exchange and how coordination systems should be constructed.

"Committee on Promotion and Study of High Reynolds-Number Aerodynamic Test Engineering Research" (chairman: Mr. Hirotoshi Kubota, Professor of Engineering, University of Tokyo) was formed from the viewpoint that Japan should make every effort to raise its level of aerodynamic test technologies so that they will come close to those of the United States and Europe. This is essential to the development of the next generation aircraft. Especially in the field of wind tunnels, research in high Reynolds-number aerodynamic test engineering designed to represent accurately a flow surrounding an aircraft frame in actual flight is considered one of the most important research areas. In this connection, the committee will search for a means of establishing a technology which can make international contributions.

"Committee on Survey of Commissioned Research Project for Next Generation Space Technology" (Chairman: Mr. Katsuya Nakayama, Professor of Hiroshima Institute of Technology) will study specific means of supporting Japanese companies' R&D efforts as space industry's ability to compete internationally is becoming increasingly more important today. The aim of the "Committee on Commercialization Trend in Europe's Space Industry" (Chairman: Mr. Toshio Okamoto, Chief, Broadcasting Satellite Section, NEC Space Development Enterprise Division) is to survey various activities of European space industry focusing on both governmental and business sectors. International competition and cooperation in the space industry are rapidly expanding. As the result of commercialization, every country is strengthening its ability to compete and, along with it, a move toward standardization is becoming more evident. Especially in the case of Europe, the industry is considerably energized by the formation of the European Community and reorganization of businesses. The committee's aims are to obtain clear understanding of the actual state of Europe and to use it as reference in its effort to assist the Japanese industry in finding direction to which it should be moving.

SJAC Advises Larger-Scale Development Programs

94FE0900F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 1 Aug 94 p 14

[FBIS Translated Text] With the revision of the Fundamental Policy of Japan's Space Development Program coming soon, the Society of Japanese Aerospace Companies, Inc. (SJAC; Chairman: Mr. Kentaro Aiukawa) has prepared "A Survey Report Concerning the Trend for Japan's Space Policy" incorporating the wishes of the industry so that they will be reflected in the revision. As we move toward the 21st century, in a technical state such as Japan, the cutting-edge-knowledge-intensive space industry is expected to develop into a nucleus industry. From this standpoint, the report stresses that it is very important for our government to devote its effort to make the space industry's foundation stronger and more substantial.

The report consists of the following four parts:

(1) the significance of the space industry;

(2) the present state of the space industry;

(3) a desirable future image of the space industry; and

(4) what is required of Japan's future space policy.

In terms of the total amount of our sales, the business scale of our space industry is approximately one-twentieth of that of the United States and one-third of that of Europe. The report points out a substantial difference in the degree of maturity between Japan and the United States/Europe. Accordingly, the report proposes from the standpoint of improving the industrial base a rapid expansion of the industrial scale to achieve double/triple the present scale. As its means, appropriation of public investment fund to the space development and possible utilization of ODA fund for assisting developing countries in using space technology.

In promoting the future space development project, the report proposes that existing main R&D organization's space development policy planning setup must be thoroughly reviewed so that more comprehensive policy dealing with not only R&D, but also development of a practical area supporting commercialization can be established. The reason, as pointed out by the report, is that the present business venture is low in profitability, thereby considerably lagging behind the United States and Europe in the area of commercialization. This cripples Japan's ability to compete successfully in the international market. In drawing up a policy, the report points out, it will be important for the government to make medium- to long-range plans. This will allow industry to facilitate its plans for investment in equipment and R&D. Moreover, in the space industry's future image, the industry is divided into two fields, one dealing with the country's space development and the other with the commercial market, with each field made up of future transportation, satellite, and ground systems.

Petroleum Energy Center To Conduct Soil Purification Test With Kuwait Using Bioremediation

95FE0039 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 10 Oct 94 p 7

[FBIS Translated Text] In mid-November 1994, Petroleum Exploitation Center, Inc. (PEC), in cooperation with Kuwait Institute of Scientific Research (KISR), will begin verification tests for the microbial purification of petroleum-contaminated soil. The tests will actually be carried out by Obayashi Corp.

In July 1993, KISR and PEC signed an agreement for a cooperative survey research project to deal with the clean-up of the petroleum pollution caused by the Iranian destruction of oil fields during the Gulf War. The verification tests will be conducted as a part of this project. (In July 1994, another agreement for the second phase was also signed.) The survey research project also includes the clean-up by physical and chemical processes, which will be carried out by Shimizu Construction Co., Ltd.

The bioremediation test site has been chosen to be a 1-hectare-square area, a part of the Oil Lake 102, in Al Burgan, Kuwait. If soil is polluted to a high degree, it may be treated with physical and/or chemical processes prior to a microbial process. The bioremedial techniques to be used include land-farming, furrow-composting, and aerated-soil-pile methods. With each method, the required area, the required water quantity, the amount of microbes to be added, and other additives' quantities will be determined.

The land-farming method is typically used for soil with a light degree of pollution, less than 30 cm; polluted soil and microbes are mixed for processing. The furrow-composting method, which is suitable for soil with a medium degree of pollution, requires periodic furrowing of polluted soil containing microbes. The aerated-soil-pile method, designed for treating soil with a high degree of pollution, tries to create aerobic conditions by installing aeration pipes in the center of each furrow. Microbes to be used in these tests have not yet been decided. There are petroleum-decomposing bacteria discovered in the United States. It is possible to use new bacterial species if promising ones can be discovered near the test site.

MOE Announces Bio-related Special Research for FY94, Priority Research for FY95

95FE0040A Tokyo NIKKEI BIOTECHNOLOGY in Japanese 29 Aug 94 p 17

[FBIS Translated Text] At the end of July 1994, the Ministry of Education announced 10 new FY94 special research project titles and 23 FY95 priority research project titles in new fields. Of those projects, all of which are to receive grants from the scientific research fund, four special and eight priority research projects are related to biotechnology. They are summarized below.

The 10 new FY94 special research project titles were chosen out of 86 newly proposed ones. Together with 29 on-going special research projects, there will be a total of 39 special research projects in FY94. The total FY94 research grant will be ¥2.297 billion, a slight increase of 2.3 percent over the FY93 figure.

FY94 New, Biotechnology-related Special Research Projects

1. Project Title: Chemistry and New Developments in Plant Toxins

   Project Leader: Shumin Ichihara (Professor, Faculty of Agriculture, Hokkaido University)

   Research Term: FY94 through FY96

   Grant: ¥193 million

   Research Outlines: A variety of physiologically active substances, including plant hormones, have been isolated from pathogenic fungi. It is possible to develop new agriculturally useful chemicals and medicines from these substances. These substances are bio-synthesized as a result of unique biochemical reactions. Thus, if these processes can be clarified, the understanding can be applied to develop new biological functions or solve problems of food poisoning.

2. Project Title: Study of Genetic Recombination Systems of Eucaryotes

   Project Leader: Hideyuki Ogawa (Professor, Faculty of Science, Osaka University)

   Research Term: FY94 through FY98

   Grant: ¥267 million

   Research Outlines: Using genes that closely resemble recA, which is involved in the recombination molecular mechanism and is found in procaryotes of even higher organisms, the genetic recombination of eucaryotes will be studied to clarify its mechanism, control factors, and apparatus to be used. Emphasis will be placed on the clarification of a recombination apparatus that works at the beginning of the process, and the recognition mechanism for homology.

3. Project Title: Study Concerning Molecular Cell Mechanism in Cytoplasmic Inheritance

   Project Leader: Tsuneyoshi Kuroiwa (Professor, Research Section, Department of Science, Graduate School, Tokyo University)

   Research Term: FY94 through FY97

   Grant: ¥175 million

   Research Outlines: The molecular cell mechanism in cytoplasmic inheritance will be clarified based on the concept that organelles use a special mechanism to multiply themselves through binary fission, and transmit their traits and DNAs to their offsprings by cytoplasmic inheritance.

4. Project Title: Origin of Natural Mutation and Its Control Mechanism

Project Leader: Mutsuo Sekiguchi (Professor, Biological Defense Medicine Research Institute, Kyushu University)

Research Term: FY94 through FY96

Grant: ¥152 million

Research Outlines: The mechanism with which animals maintain the rate of natural mutation at an extremely low and constant level will be clarified at the molecular level. During the course of the clarification, the cDNAs and the genes of proteins that play important roles will be cloned; the cloned products will be purified, and their functions will be studied in a test tube. Mice that are deficient in one of the particular genes will be created to study the rate of mutation and the rate of carcinogenesis among them.

FY95 New, Biotechology-related Priority Research Projects

1. Priority Field: Structural and Functional Cooperation/Coordination Between Channel and Transporter

Field Leader: Yasunobu Okada (Professor, Okazaki National Inter-University Physiological Research Institute)

Research Term: FY95 through FY97

Grant: ¥670 million

Research Outlines: Structural and functional similarities and dissimilarities between channel and transporter, which are closely related to each other, will be studied at the molecular level. Their structural and functional conjugate function transversion mechanisms will also be studied. Through these studies, the mechanism of cytoplasm transport, which is a fundamental vital phenomenon, will be thoroughly clarified.

2. Priority Field: Basic Studies Concerning AIDS Symptoms and Control

Field Leader: Yoshiyuki Nagai (Professor, Medical Science Research Institute, Kyoto University)

Research Term: FY95 through FY97

Grant: ¥1.236 billion

Research Outlines: In order to clearly understand and be able to control AIDS symptoms, the modes of virus infection will be determined, and all the factors of the virus and its hosts concerning the deficiencies in immune responses and immune functions will also be identified. The project will be carried out under the following topics:

(1) reproduction mechanism of HIV;

(2) virological basis for the symptoms;

(3) immunological basis for the symptoms;

(4) study of the symptoms with animal models; and

(5) control of infection and symptoms.

3. Priority Field: Molecular Mechanism of Neuro-Plasticity

Field Leader: Takao Shimizu (Professor, Faculty of Medicine, Tokyo University)

Research Term: FY95 through FY98

Grant: ¥1.4171 billion

Research Outlines: The mechanisms of the brain's sophisticated functions, particularly memory and learning, will be clarified. To achieve the objective, the molecular mechanism for the plasticity of each individual synapse using a knock-out mouse will be analyzed; also, plasticity-related genes will be sought and their functions analyzed.

4. Priority Field: Functional Development of Neural Circuit

Field Leader: Tadaharu Tsumoto (Professor, Faculty of Medicine, Osaka University)

Research Term: FY95 through FY98

Grant: ¥1.468 billion

Research Outlines: Focusing on the mechanisms for developing a neural circuit during the middle to later periods of the process for a complicated neural network to be formed from a fertilized egg, studies will be made under the following four topics: (1) molecular mechanisms for selective neural circuit formation; (2) gene manifestation due to neural activities, and control mechanism thereof; (3) synapse reinforcement and fixation mechanisms due to neural activities; and (4) synapse suppression and regression mechanisms in neural circuit modification.

5. Priority Field: Principles for Building Solid Protein Structures

Field Leader: Nobuhiro Go (Professor, Faculty of Science, Kyoto University)

Research Term: FY95 through FY98

Grant: ¥900 million

Research Outlines: To establish a method of deciphering a protein's solid structure from its amino acid sequence, obtained by genetic analysis, an attempt will be made to develop: (a) a natural scientific method for comparatively analyzing solid structures of many proteins whose amino acid sequences have already been clarified; and (b) a physicochemical method for comparatively analyzing the structural stability of systematic amino acid derivatives of a few proteins.

6. Priority Field: Genetically Anatomical Examination of Gender Differentiation and Pollination Processes Among Higher Plants

   Field Leader: Kokichi Hyuga (Professor, Faculty of Agriculture, Tohoku University)

   Research Term: FY95 through FY98

   Grant: ¥891 million

   Research Outlines: Various switching mechanisms for plant's gender differentiation and the intercellular information recognition mechanism during the pollination process will be thoroughly studied from the standpoint of molecular biology, in order to obtain insight into the sexual reproduction mechanism, an important, elementary process in the life cycle of higher plants.

7. Priority Field: Functional Structure of Cell Nucleus: Molecular Building and Intermolecular Communication

   Field Leader: Shigeki Mizuno (Professor, Faculty of Agriculture, Tohoku University)

   Research Term: FY95 through FY98

   Grant: ¥1.026 billion

   Research Outlines: Considering a cell nucleus to be an orderly aggregate of various functional structure domains, studies at the molecular level will be made to clarify the construction of these domains and their relationships to intranuclear reactions. Also, the mechanism of polymer transport occurring between the nucleus and those cytoplasms which are closely related to information transmission and genetic manifestation will be analyzed.

8. Priority Field: Mechanism of Reproductive Cell Formation and Meiotic Transition

   Field Leader: Masayuki Yamamoto (Professor, Research Section, Department of Science, Graduate School, Tokyo University)

   Research Term: FY95 through FY98

   Grant: ¥842 million

   Research Outlines: Clarification of the molecular mechanisms for the division and behavior of gametogenic reproductive cells will be pursued under the two topics:

   (1) molecular mechanism for the formation of reproductive cells; and

   (2) characteristics and control of meiosis.

Juntendo University Succeeds in Basic Experiment for Gene Therapy to Suppress Cancer Growth

95FE0059A Tokyo NIHON KEIZAI SHIMBUN in Japanese 15 Oct 94 p 14

[FBIS Translated Text] Professor Yasushi Okumura and Research Assistant Kazunori Kato at the Faculty of Medicine, Juntendo University, have successfully carried out a basic experiment concerning a new gene therapy for suppressing cancer growth by means of the immunity mechanism. The trick was to combine a protein-producing gene, called B7, with a cancer cell to make it easier for the cell to combine with a lymphocyte. The lymphocyte, once combined with the cancer cell, becomes more capable of recognizing the cell to be cancerous. With the proliferation of the lymphocyte, the cancer cells will be attacked. The group hopes to develop an effective cancer treatment by combining this method with another technique for promoting the proliferation of the lymphocytes. The group is scheduled to give a paper on this achievement at the meeting of the Japan Society of Oncology to be held in Nagoya City, beginning 19 October 1994.

In order for a T cell (a type of lymphocyte) to be able to attack a cancer cell, it is necessary for the T cell to attach itself to the cancer cell and receive information that this cell is a foreign object. T cells attack cells that have a protein called B7, which is the target of the T cells' attack. T cells cannot unite with cancer cells because cancer cells do not have the B7 protein.

The Juntendo University research group incorporated the B7 protein-producing gene into a cancer cell which had been taken from fibroblast sarcoma. For purposes of comparison, the group hypodermically injected two groups of mice with ordinary cancer cells and cells combined with the gene. The mice injected with the ordinary cancer cells all developed tumors and died. Eleven of the 14 mice that had been injected with the cancer cells combined with the B7 gene never developed tumors. It is conjectured that T cells, which were able to contact the cancer cells to receive sufficient information, multiplied themselves and attacked the cancer.

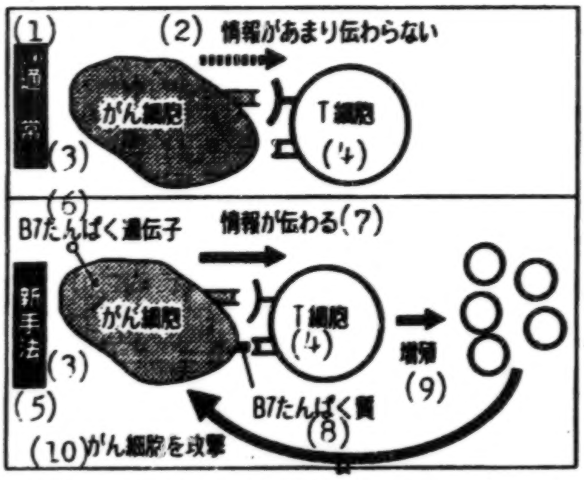
The group also discovered that the mice that had been injected with the B7 gene-recombinant cancer cells were not victimized by the cancer after being subsequently subjected to the injection of ordinary cancer cells. According to the group, T cells, once attached to the cancer cells, were said to be capable of remembering the information for discriminating the cancer and multiplying themselves through the inheritance of this memory.

Furthermore, the group confirmed similar effects with intestinal and pulmonary cancer cells in mice. The group carried out test-tube experiments with human cancer cells and confirmed that B7 protein gene-incorporated cancer cells promoted the proliferation of T cells.

Today, the group is investigating the therapeutical effect of injecting the B7 protein gene-incorporated cancer cells into mice that have already developed tumors. "The injection appears to have effectively suppressed the growth of cancer," stated Research Assistant Kato.

Many researchers are conducting basic experiments to develop a new gene therapy for cancer by incorporating genes that produce cytokine, the substance capable of

promoting the proliferation of T cells, into cancer cells. Such a therapy is not necessarily effective against all types of cancer. However, it is possible to make the therapy more effective by combining it with the method developed by the Juntendo University group, i.e., the use of B7 to strengthen the adhesion between cancer cells and T cells.



Key: (1) Ordinary case (2) Little or no information transmitted (3) Cancer cell (4) T cell (5) New technique (6) B7 protein gene (7) Information transmitted (8) B7 protein (9) Multiplication (10) Attack on cancer cell

Oki Electric Industry Co. Develops Biosensor Mimicking Biological Senses

95FE0059B Tokyo OKI DENKI KENKYU KAIHATSU in Japanese 1 Jul 94 pp 37-42

[Article by Minoru Saito, Material Technology Research Department, Basic Technology Research Institute, R&D, Oki Electric Industry Co., Ltd.]

[FBIS Translated Text]

Synopsis

Biosensors based on a quartz oscillator and an excitable lipid membrane, respectively, were studied in an attempt to develop new, highly functional biosensors capable of mimicking biological senses for taste and smell. The biosensor using a quartz oscillator was found to be capable of converting chemical substances into electric signals, analogous to biological senses, and hinted possible applications as sensors for disaster-prevention and environmental measurements. On the other hand, the biosensor using an excitable lipid membrane was found to be more closely related to the gustatory and olfactory senses, capable of acquiring more information and being more sensitive to chemical substances than the biosensor using a quartz oscillator.

1. Introduction

Biosensors are expected to be utilized in a wide range of fields, including medicine, environmental measurements, and the safety evaluation of chemicals. Shown in Figure 1 is the basic composition of biosensors that have been studied in the past. The molecular recognition section senses chemicals with specificity by means of an excellent biological molecular recognition function. The type of molecular recognition section determines whether a biosensor is an enzyme, immune, or microbial sensor. Already, some enzyme and microbial sensors have been implemented in the medical and environmental measurement fields.

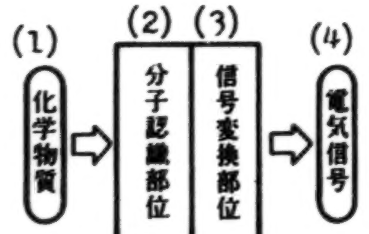


Figure 1. Composition of Traditional Biosensors

Key: (1) Chemical substance (2) Molecular recognition section (3) Signal conversion section (4) Electrical signal

Today, greater hopes are placed on the development of highly functional biosensors that are capable of recognizing complex chemical compositions, as represented by taste and odor, rather than the development of traditional monofunctional biosensors that can sense a single chemical substance. At Oki Electric Industry Co., Ltd. (Oki Electric), the author's group is trying to develop highly functional biosensors of a new type that can mimic biological sensory functions, such as gustatory and olfactory senses.

This article will describe two examples of biosensors that the group has studied: one using a quartz oscillator, and another using an excitable lipid membrane.

2. Mechanisms for Biological Sensory Functions

As is well known, higher living organisms possess the visual, auditory, gustatory, olfactory, and somatic (touch, pressure, and temperature) senses (the so-called five senses). The mechanism for each of these sensory functions is such that respective sensory cells receive external stimuli which are converted into neural impulses through codification (digitalization). For example, the mechanisms of gustatory and olfactory functions are illustrated in Figure 2, i.e., when an external stimulus is adsorbed on the receptive membrane, the cell potential of gustatory or olfactory cells undergoes change. This potential change is increased analogously as the concentration of the stimulus is increased. With the change in potential, gustatory cells will release a transfer substance which acts on the

terminals of the gustatory nerve to urge impulse generation. On the other hand, olfactory cells, when a potential change occurs, force the olfactory nerve to generate an impulse directly rather than going through a synapse.

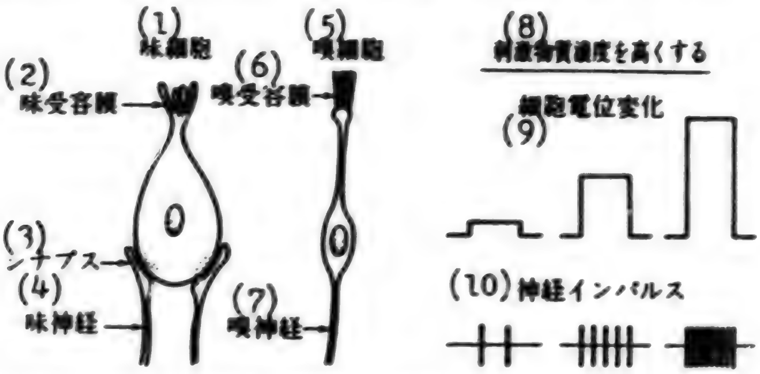


Figure 2. Gustatory and Olfactory Cells

Key: (1) Gustatory cell (2) Gustatory receptive membrane (3) Synapse (4) Gustatory nerve (5) Olfactory cell (6) Olfactory receptive membrane (7) Olfactory nerve (8) Increase the concentration of stimulus (9) Changes in cell potential (10) Neural impulses

The neural impulses which have been generated as described above are transmitted, through the sensory nerve, to the respective sensory center in the brain, where they undergo sophisticated information processing. The mechanisms for the information processing in the gustatory and olfactory functions have not yet been thoroughly clarified. However, as shown in Figure 3, it is said that responses of the gustatory and olfactory cells are not specific, and the recognition of taste or smell is made based on a response pattern of many cells with different response characteristics.

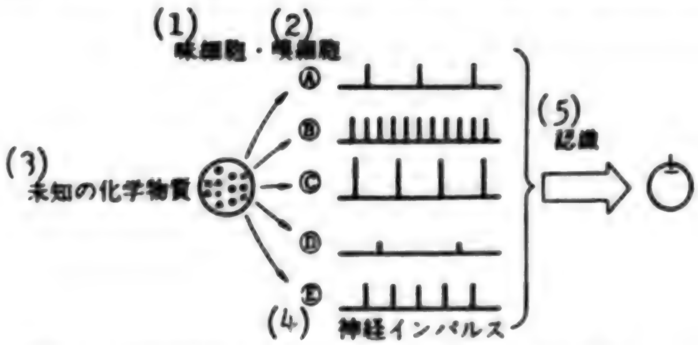


Figure 3. Mechanism of Biological Sense of Taste or Smell

Key: (1) Gustatory cell (2) Olfactory cell (3) Unknown chemicals (4) Neural impulses (5) Recognition

3. Biosensor Using Quartz Oscillator

It has been known that a quartz oscillator can detect a change in mass on the order of a nanogram (ng) through the reduction in its oscillation frequency in proportion to the mass of chemicals adhered on the electrode. Also, the oscillator resembles a gustatory or olfactory cell in that electrical signals converted from chemical substances are oscillation frequencies. Therefore, attempts have been made to apply a quartz oscillator to a biosensor that mimics the gustatory or olfactory sense. Shown in Figure 4 is the schematic diagram to illustrate the principle of a biosensor using a quartz oscillator. The author's group used a phthalocyanin vapor deposition membrane as the sensing element to prepare a biosensor that can detect chemical substances.

For some time, Oki Electric has been studying phthalocyanin (see Figure 5) to develop a photosensitive material for electronic photographs, and the material has also been known to respond t chemicals. In addition, phthalocyanin has excellent stability against heat, light, weather, and chemicals. In the Figure 6 graphs, the frequency changes of a quartz oscillator with vapor-deposited copper phthalocyanin (whose structure is the one shown in Figure 5, where M is Cu) are plotted against time for benzaldehyde and

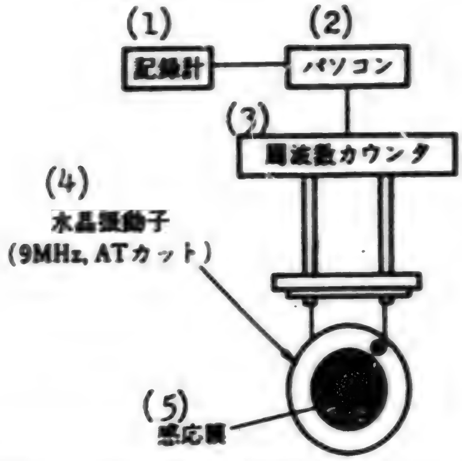


Figure 4. Schematic Illustration of Biosensor Using Quartz Oscillator

Key: (1) Recorder (2) Personal computer (3) Frequency counter (4) Quartz oscillator (5) Sensing membrane

triethylamine, respectively. In these graphs, a frequency change of 1 Hz corresponds to a mass change of approximately 1 ng. For each of the chemicals tested. the oscillator began to show frequency changes whenever the concentration of the chemical exceeded approximately 100 ppm.

(1) M : H_2, Cu, Co, Zn, Pb, Mgなど

Figure 5. Structural Formula of Phthalocyanin

Key: (1) M may be H2, Cu, Co, Zn, Pb and Mg.

Benzaldehyde is one of the characteristic smells generated in a fire, and triethylamine is a typical putrefaction smell. Therefore, this particular sensor using the quartz oscillator can be applied for fire prevention and environmental protection. However, this sensor responds to chemicals without specificity. Thus, it is necessary to use a completely different sensing membrane to develop a

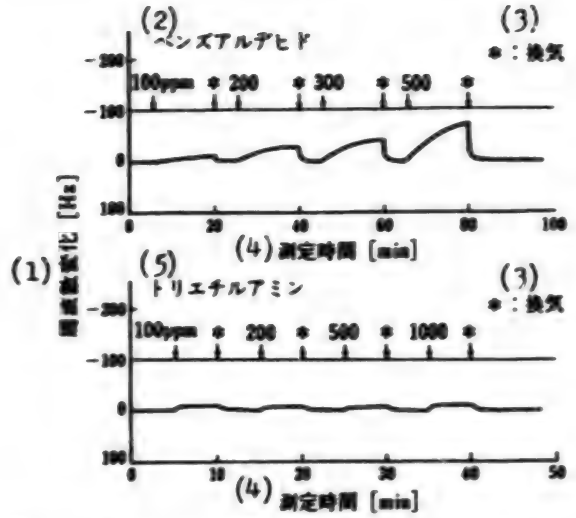


Figure 6. Responses of Oscillating Frequency of Quartz Oscillator to Chemical Substances

Key: (1) Frequency change [Hz] (2) Benzaldehyde (3) Ventilation (4) Time [min] (5) Triethylamine

sensor that shows different responses to different chemicals, such as with biological sensors for tastes and smells. The different responses or patterns of such a sensor should enable us to distinguish one chemical from another.

4. Biosensor Using Excitable Lipid Membrane

4.1 Excitable Lipid Membrane

An excitable lipid membrane was prepared through the adsorption of a synthetic lipid, di-oleyl phosphate (shown in Figure 7.1, to be represented by DOPH hereinafter), which resembles the phospholipid that forms biological membranes, onto a porous membrane, called Milipore filter, with pore sizes measuring in fm. This lipid membrane will hereinafter be called DOPH membrane. As schematically illustrated in Figure 8, a DOPH membrane is sandwiched between two cells connected by a hole with a diameter of several centimeters on the side wall of each cell. When a concentration gradient was created between the salt solutions in the cells on both sides of the membrane, or when a current or voltage was applied across the membrane, one could observe periodic oscillations (as shown in Figure 9) or chaotic oscillations (as shown in Figure 10). These oscillations were generated by the opening and closing of pores of the Milipore filter as a result of changes in the aggregate status of DOPH molecules that had been adsorbed on the Milipore filter. The mechanism for this phenomenon is schematically illustrated in Figure 11. Also, a scanning electron microscope was used to observe the closed (Photograph 1a) and open (Photograph 1b) pores.

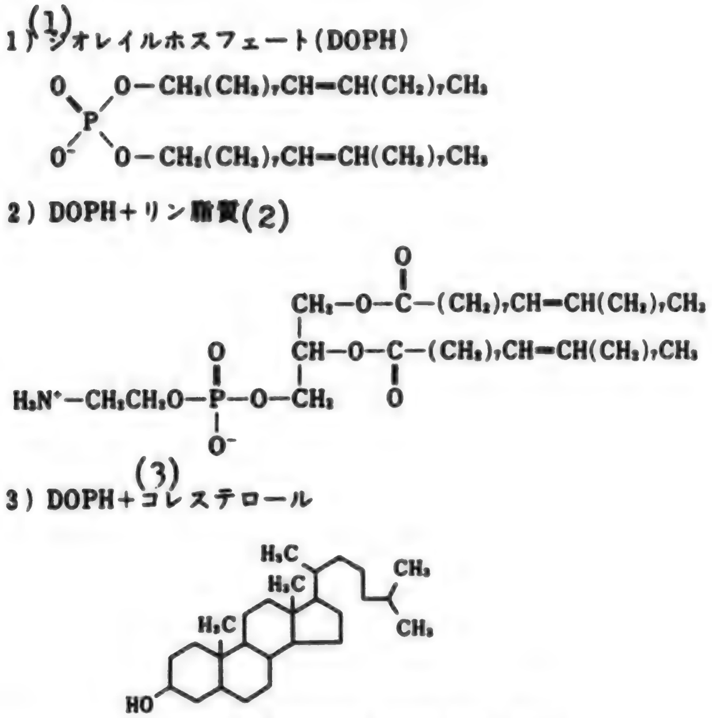


Figure 7. Structural Formula of Lipids

Key: (1) Di-oleyl phosphate (DOPH) (2) Lipid (3) Cholesterol

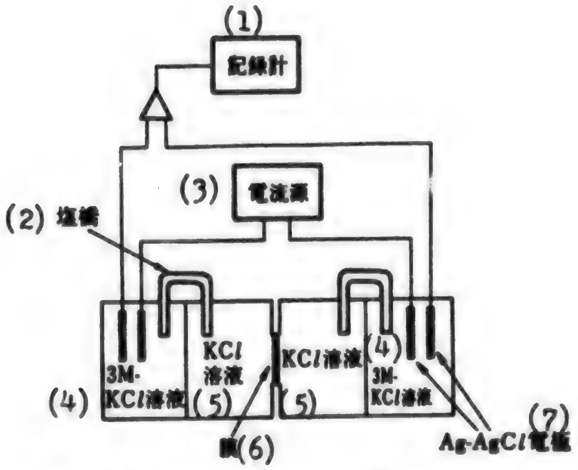


Figure 8. Schematic Illustration of Biosensor Using Excitable Lipid Membrane

Key: (1) Recorder (2) Salt bridge (3) Current source (4) 3M KCl solution (5) KCl solution (6) Membrane (7) Ag-AgCl electrodes

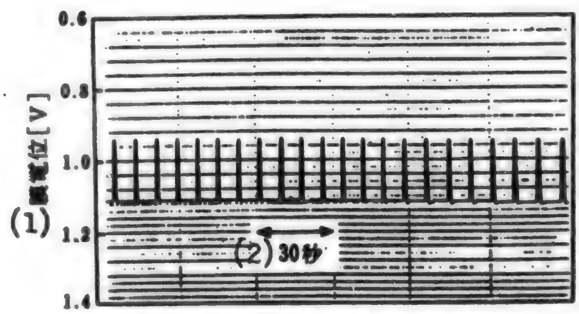


Figure 9. Example of Periodic Oscillations

Key: (1) Membrane potential [V] (2) 30 seconds

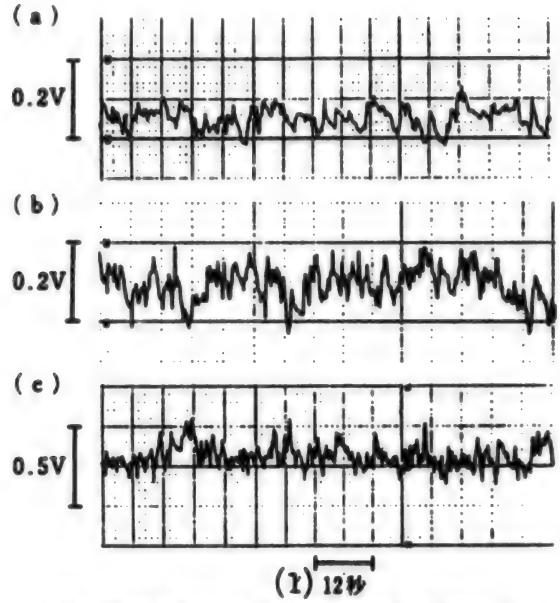


Figure 10. Examples of Chaotic Oscillations
Key: (1) 12 seconds

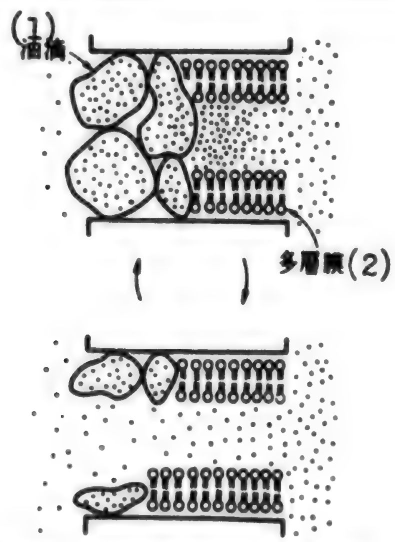
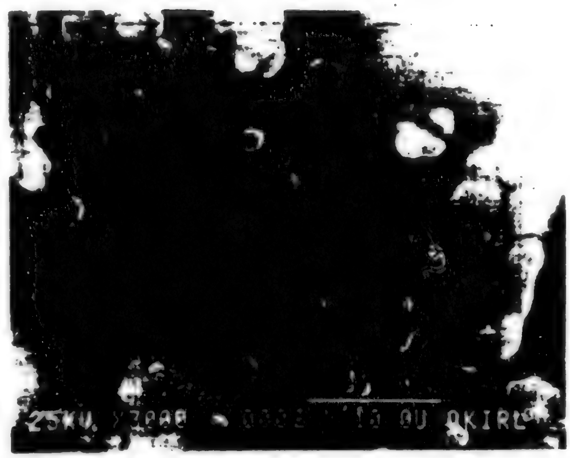


Figure 11. Mechanism of Oscillations
Key: (1) Oil drop (2) Multilayer membrane

Only one of the many pores in the membrane is undergoing the open-and-close motion in the periodic oscillation, whereas several pores are simultaneously undergoing the same in the chaotic oscillation. Thus, the membrane in the periodic oscillation can be regarded as a model for one neural cell, and the membrane in the chaotic oscillation can be regarded as a model for a cerebro-neural system. The author's group focused attention on the chaotic oscillation, which was more stable and durable than the periodic oscillation, and examined membrane responses against different chemicals.



(a)

(b)

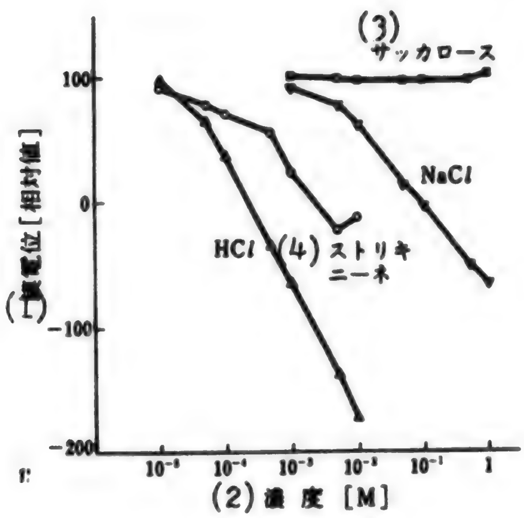
Photograph 1. SEM Photographs of Excitable Lipid Membrane Surface

4.2 Detection of Chemicals by Changes in Potential and Resistance of Excitable Lipid Membrane

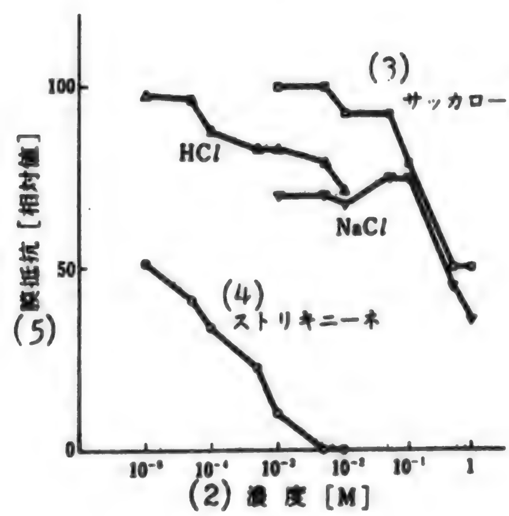
Prior to checking oscillation changes caused by chemicals, changes in membrane potential and resistance caused by chemicals were investigated under conditions involving no oscillation. The cells were filled with 100-mM and 5-mM KCl solutions, respectively, and a chemical substance to be detected was added to the 5-mM KCl solution. Strychnine (a bitter substance), HCl (a sour substance), NaCl (a salty substance), and saccharose (a sweet substance) were used for the study. Generally speaking, tastes consist of the bitter, sour, salty, and sweet components, as in these materials.

Changes of the DOPH membrane potential and resistance are shown as the function of the concentrations of the four chosen chemicals—strychnine, HCl, NaCl, and saccharose—in Figures 12a and 12b. The values of potential and resistance are given as relative values based on the base values prior to the addition of a chemical which is set as

100. The absolute membrane potential and resistance values prior to the addition of a chemical were approximately -60 mV (with the 5-mM side cell as the standard) and 5 Mohm, respectively. As the graphs indicate, the addition of each of the four chemicals caused uniquely different changes in membrane potential or resistance. Therefore, it was proved that these chemicals could be detected distinguishably.



(a)



(b)

Figure 12. Responses of DOPH Membrane to Chemicals in Terms of Membrane Potential and Resistance

Key: (1) Membrane potential [relative value] (2) Concentration [M] (3) Saccharose (4) Strychnine (5) Membrane resistance [relative value]

The next task was to determine whether a sensor can be used to recognize a complex taste. In order to increase the volume of information regarding chemical substances, two additional membranes that had different responses to chemical substances from that of the DOPH membrane were prepared. One was made by combining DOPH with natural phospholipid (Figure 7-2), and the other was made by combining DOPH with cholesterol (Figure 7-3) (hereinafter to be called phospholipid mixed membrane and cholesterol mixed membrane, respectively). It had already been reported that these membranes had responded differently from the DOPH membrane to the above-mentioned four chemicals in terms of membrane potential and resistance. Shown in Figure 13 are the graphical response patterns of the three different membranes in terms of membrane potential and resistance to the tastes of coffee, orange and apple. In the graph, E1, E2, and E3 represent membrane potential values of the DOPH, phospholipid mixture, and cholesterol mixture membranes, respectively; and R1, R2, and R3 represent membrane resistance values of the same three membranes, respectively. Thus, it was discovered that these tastes could be distinguished because these membranes showed different response patterns in terms of changes in membrane potential and resistance to these tastes.

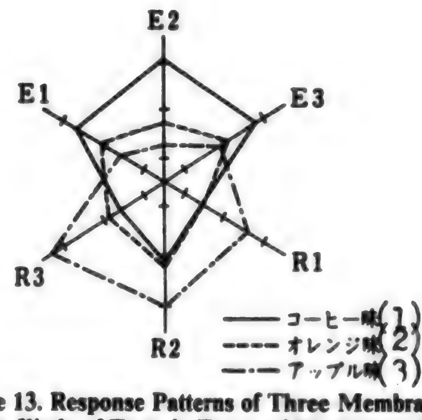


Figure 13. Response Patterns of Three Membranes to Different Kinds of Taste in Terms of Membrane Potential and Resistance

Key: (1) Coffee taste (2) Orange taste (3) Apple taste

4.3 Chemical Substance Sensing by Change in Oscillation of Excitable Lipid Membrane

As described above, it became clear that it was possible to detect chemical substances to a degree by taking advantage of changes in membrane potential and resistance of the three kinds of excitable lipid membranes. However, in order to gain higher sensing capability of this type, a larger amount of information is required. Therefore, changes in chaotic oscillation were investigated. First, the two cells on both sides of the membrane

were filled with 1-mM KCl solution, and chaotic oscillation was caused by applying DC currents of 1 nA. Under these conditions, a chemical substance was added to both cells.

Using the cholesterol mixture membrane and strychnine as the chemical substance, chaotic oscillations of the membrane were plotted against time in Figure 10. The graph in Figure 10a was taken prior to the addition of strychnine; the graph in Figure 10b was taken when 10^{-6} M strychnine was added; and the graph in Figure 10c was taken when 10^{-5} strychnine was added. After the addition of strychnine, the oscillation became further disturbed.

In order to quantify these chaotic oscillations, the time series of oscillations were sampled, and their correlation dimensions were calculated. A correlation dimension is one of the fractal dimensions, and in this particular case, the correlation dimension reflects the orderliness of a system, i.e., the correlation of opening and closing of membrane pores. Shown in Figure 14 are the correlation dimensions of the DOPH membrane as the functions of the concentrations of chemical substances, i.e., strychnine, HCl, NaCl, and saccharose. These values for the correlation dimensions are relative to the value prior to the addition of any chemical substance, to which a value of 100 has been assigned. Actually, the correlation dimension of the membrane prior to the addition of any chemical was approximately 10. As can be seen in Figure 14, the correlation dimension of the membrane changed with the addition of each chemical substance. It was also found that the phospholipid mixture membrane and the cholesterol mixture membrane each showed different correlation dimension responses to these four chemical substances from those of the DOPH membrane. It was further discovered that the differences in correlation dimension responses of the different membranes showed no correspondence to the differences in membrane potential and resistance responses of the membranes. Thus, the oscillation responses of the three membranes become totally independent information from that of the previously discussed responses of the membranes in terms of membrane potential and resistance. This means that it is possible to sense chemical substances to a reasonably higher degree by combining the independent sets of information.

It will also be possible to obtain more information than only one parameter, such as correlation dimension, by using the chaotic oscillation as described above. For example, plotted in Figure 15 is the pattern of time-series oscillation in response to strychnine. Thus, the time series of oscillation was expressed graphically by successively plotting the nth potential (Vn) and the (n+1)th potential (Vn+1), and correspondence was made between strychnine and this time series pattern of simple shapes. Also, in this situation, it is speculated that a certain orderly structure is formed in many pores of the membrane, and a similar phenomenon has been discovered in a living brain (the olfactory sense of rabbit).

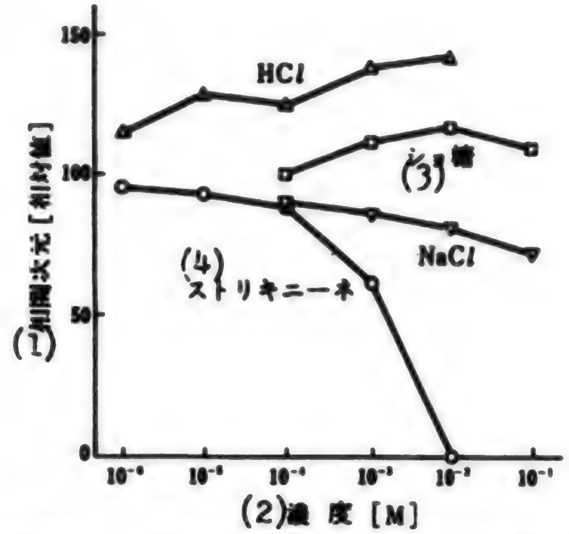


Figure 14. Correlation Dimension Responses of DOPH Membrane to Chemical Substances

Key: (1) Correlation dimension [relative value] (2) Concentration [M] (3) Sucrose (4) Strychnine

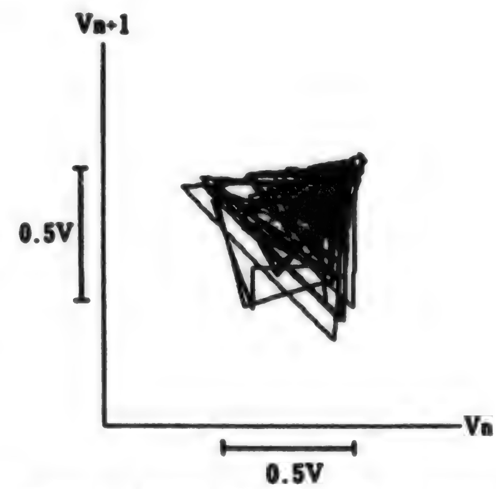


Figure 15. Pattern of Time-Series Oscillation in Response to Strychnine

5. Postscript

A biosensor using a quartz oscillator and another biosensor using an excitable lipid membrane were developed as models for a new type of highly functional biosensor that mimics biological sensory functions for taste and smell. Like biological sensors, the biosensor using a quartz oscillator has a mechanism that converts chemical substances into electrical signals. It was suggested that such sensors could be implemented for disaster prevention and environmental measurements.

For the future, however, it will be necessary to develop plural sensors with different responses to chemical substances.

The biosensor using an excitable lipid membrane more closely approximates the biological gustatory and olfactory sense. This biosensor gives static responses in terms of membrane potential and membrane resistance, and also yields dynamic responses in terms of oscillation change to chemical substances. Thus, more information can be obtained with this biosensor than the other using a quartz oscillator, and it is expected that more highly capable sensors for chemical substances will be developed based on the principle of the biosensor using an excitable lipid membrane.

University of Electrocommunications, RIKEN Succeed in Experiment in Optical Switching Using Bioelement

95FE0059C Tokyo NIHON KEIZAI SHIMBUN in Japanese 12 Oct 94 p 13

[FBIS Translated Text] Research Assistant Yoshiko Okada of the Electronic Engineering Department, Electrocommunications University, and Special Basic Science Researcher Hiroaki Tomioka of the Institute of Physical and Chemical Research (RIKEN) have conducted successful experiments using a bio-chip made of a biological material to turn a light on and off, as well as to separately gather light rays of different wavelengths (wavelength division). The biological material is a thin-film form of a pigment protein taken from a bacterium called *bacteriorhodopsin*. At a low temperature, the chip can be actuated at an ultrahigh speed on the order of picoseconds (one picosecond is 1/1,000,000,000,000 of one second). Among proteins, bacteriorhodopsin is said to be extraordinarily sturdy and superbly durable.

The real-time holographic function of the bacteriorhodopsin film was utilized for both optical switching and wavelength division.

In the case of optical switching, while two laser beams were hitting the film from both sides at a right angle to the film, another laser beam (input beam) irradiated the film at an oblique angle. Under these circumstances, similar to holography in principle, an output beam was emitted from the film in the same direction as that of the obliquely incident beam. The polarization plane of the output beam could be changed by varying the polarization plane of the perpendicularly incident beam irradiating the back side of the film. Thus, the output beam could be switched on or off with a polarizing plate, while maintaining the polarization plane of the input beam at a constant angle.

In the case of wavelength division, a concentric hologram was written into the bio-chip. The chip, like a Fresnel lens, could gather light beams other than the write beam, and the focal point of light convergence would shift dynamically with the light's wavelength. Since it was possible to calculate in advance how much a shift would occur, several optical fibers could be installed at each precalculated focal point to guide several light beams with different wavelengths to different places.

Optical switching devices hold a critical key for the development of optical communication technology. However, today, the devices are faced with many problems, including that of cost and actuation characteristics. Bacteriorhodopsin, which can be mass-produced simply by cultivating bacteria, may be able to dramatically reduce the cost of high-performance switching devices.

Osaka University Develops Technique That Recreates Natural DNA Self-Replication

43070020A Tokyo THE NIKKEI WEEKLY in English 12 Dec 94 p 13

[FBIS Transcribed Text] A group from Osaka University has shuffled an evolutionary wild card into the polymerase chain reaction (PCR), the technique widely used by scientists to amplify stretches of DNA in the test tube.

The researchers call their modification of the PCR technique a "pseudo life system," since it recreates the natural process of DNA self-replication, with its seemingly inherent tendency to mutate and evolve. They also see it as a tool to bioengineer useful proteins, to study cellular functions and to investigate the process of evolution at the molecular level.

PCR lets scientists mass-produce a specific DNA fragment, even when all they have to start with is a single copy. The technique is now used everywhere from genetic labs to forensic labs.

But while the technique is useful, it does not simulate the natural process of DNA self-replication because the polymerase enzyme that controls replication is added as a separate ingredient to the reaction system and is independent from the DNA being replicated.

The Osaka group's new method couples the two by inserting the gene for polymerase into the very DNA that is to be mass-produced. This links their fates.

Secret Decoders

To decode the gene and get at this polymerase, the researchers also add ribosomes to the reaction system. Ribosomes are the cellular machinery that assemble proteins according to DNA instructions.

First, the ribosomes make the polymerase by reading the gene encoded in the DNA, and then this polymerase turns around and makes copies of the DNA. By repeating the process, multiple copies of the DNA can be produced, just as in standard PCR. The important difference is that the polymerase and the other information

coded in the DNA fragment can "evolve" as mutations arise in the genetic code and natural selection works to spotlight those changes that are the fittest.

The system thus provides a way to direct the process of protein evolution. For example, by replicating the DNA in a high-temperature environment, the DNA which comes to dominate in the test tube is the DNA with a polymerase that works best at high temperatures. Similarly, if amplification is conducted in an acidic environment, only the DNA which can survive in strong acids remains to replicate.

So far, the researchers have only run the process on small DNA fragments encoding polymerase. However, they believe that the same system could be used on DNA encoding additional information, such as medically useful proteins like insulin or interferon.

Development of Microwave Transmission

43070019A Tokyo THE NIKKEI WEEKLY in English 5 Dec 94 p 13

[Article by Junichi Taki, senior staff writer]

[FBIS Transcribed Text] The idea of transmitting electricity with microwaves has been kicked around since before World War II. But except for some secret military experiments by the U.S. back in 1975, there have been few examples of successful outdoor transmissions over significant distances.

Now that is changing, and labs around the world are taking a fresh look at an old idea. Power beaming is back in technological vogue.

Kansai Electric Power Co. began basic experiments on power beaming in mid-October in cooperation with Kyoto University and Kobe University. Its goal is to devise a way of supplying power to geographically remote areas that are difficult to wire up for electricity, such as national parks, mountain regions and small islands.

"We already know we can transmit electric power with microwaves. What we plan to do now is analyze data on things like transmission efficiency, and study how beaming is affected by the wind and the rain," said Naoyoshi Shimokura, program manager at Kansai Electric's Technical Research Center.

The power company can now transmit some 5 kilowatts of electricity over a distance of 50 meters using microwaves. If the current series of basic experiments are as successful as hoped, the next step is to try to transmit 100 kW over a distance of 50 meters using microwaves. If the current series of basic experiments are as successful as hoped, the next step is to try to transmit 100 kW over a distance of 3 km. This would bring the company closer to developing actual applications.

In a sense, power beaming is already here. How else do you pick up songs on your radio?

Using microwaves to transmit power is similar to using microwaves for long-distance communications, only there is no overlaid signal and the waves must be much more powerful. Kansai Electric uses 2.45 gigahertz microwaves.

In 1968, American scientists proposed the idea of rigging satellites up as solar generators, placing them in geostationary orbit, and beaming the power back down to earth in the form of microwaves. Interest picked up after the 1973 oil crisis, but the effort was put on the back burner when oil became plentiful again in the 1980s. However, Japan and France—both resource-poor countries—never lost interest in the idea.

One person who has kept the research flame burning in Japan is Horace Matsumoto, director of Kyoto University's Radio Atmospheric Science Center. When humans have burned all the fossil fuels on earth, they will look to space for energy sources, Matsumoto believes. "The future of mankind might depend on microwave power beaming," he said.

Fear of Frying

Matsumoto has been involved in a number of key studies on microwave transmissions. In 1992, working with the Ministry of Posts and Telecommunications' Communications Research Laboratory and industry groups, he conducted flights with a model airplane powered by microwaves beamed up from the ground.

And in 1993, he was in on the successful transmission of microwaves in space using a satellite launched by the Ministry of Education's Institute of Space and Astronautical Science.

Even the joint experiments with Kansai Electric are "a step toward the realization of solar power generating satellites," Matsumoto said.

While beaming power down to earth is Matsumoto's focus, other researchers look to smaller-scale applications of microwave power supplies.

For example, Kobe University's Nobuyuki Kaya, who has worked with Matsumoto, thinks this would be a good way to power robots in areas where cables get in the way, like in nuclear power plants and in space. The concept could even be applied to power electric cars traveling on high-speed roadways.

There is really no technical hurdle facing proponents of microwave power beaming. Instead, the biggest problem is public safety concerns.

Because a large antenna is used to transmit the microwaves, the energy density is relatively small and any living thing which happens to get in the way shouldn't be harmed.

"It's not like you are going to see birds flying through the area and coming out fried chicken," Matsumoto said.

Japan's current safety standards for microwave transmissions restrict power density to less than 1 milliwatt per square centimeter. Even the power beams sent down from future solar power generating satellites are expected to remain within these bounds.

However, it remains unclear whether long-term exposure to such microwaves would be harmful to humans and other living things. Studies done to date suggest there is no danger, but this is not a guarantee and further research is needed.

Science University of Tokyo Discovers Bacteria That Can Be Used to Produce Biodegradable Plastic

43070021A Tokyo THE NIKKEI WEEKLY in English 12 Dec 94 p 13

[FBIS Transcribed Text] A species of bacteria discovered living in industrial waste water can be harnessed to produce a good biodegradable plastic, according to a group from the Science University of Tokyo.

Previously, a bacteria was discovered that uses methane as its sole carbon source for energy production and synthesizes a polyester consisting of a single type of fatty acid, called 3HB.

The newly found bacteria uses formic acid in the waste water as its sole carbon source, and synthesizes a polyester which consists 97 percent of 3HB, and 3 percent of another fatty acid called 3HV.

Because of the second fatty acid, the polyester has a relatively low melting point of 168°C and is easy to process, they said.

Analysis of the composition of freeze-dried bacteria showed that the polyester accounts for 23 percent of the bacterial mass.

Separated out and processed, this polyester can be turned into a plastic material that readily degrades in the soil.

Korea and Taiwan Furiously Pursuing Japan in TFT-LCD

94FE0721A Tokyo NIKKEI ELECTRONICS in Japanese 23 May 94 pp 125-134

[Article by Tomohaku Nakamori]

[FBIS Translated Text] Korea and Taiwan have entered the world of TFT LCD panels. Mass production factories are rapidly being constructed, and the goal is to start operations in 1995-1996. Poor results are being addressed with abundant capital, and the Koreans and Taiwanese are in hot pursuit of Japanese manufacturers. "When you start out running, you can't stop." Japanese manufacturers, who feel a growing threat, are rushing to develop new technology while protecting themselves with the shield of patents.

Part 1: The Tottering Monopoly of Japan

Japanese manufacturers are feeling a never-ending drain of technology, and the danger.

Korea and Taiwan have taken up the mass production of color TFT LCD panels. Korea is thinking of using them to foster a basic export industry that will fulfill the role of becoming Korea's next semiconductor business. Taiwan would like to be self-sufficient in the parts that are indispensable to the personal computer business, which it considers to be a basic industry and, therefore, it is focusing on color TFT LCD panels. Japanese manufacturers have a growing sense of alarm in relation because of this trend. There appears to be a movement to fend off Korean manufacturers with warnings of patent infringements and termination of the supply of TFT LCD panels. However, confining the trends of the manufacturers of both countries will probably be difficult.

"Catch Up!" A large banner with the motto "Catch Up!" written on it is the first thing that strikes the eye when entering the office. There are the sounds of construction. Immediately nearby, the feverish pitch of the TFT LCD panel factory construction rushes onward. This is the atmosphere at the Samsung Electronic Device factory in Korea.

Korea and Taiwan are beginning the mass production of color TFT (thin film transistor) LCD panels. Samsung Electronics has already started small scale production of 10-inch panels. (Figure 1 [figure not reproduced].) Aiming for operations at the beginning of 1995, the first new mass production factory is under construction now. Kimsung Company is also pursuing this technology. Again, a mass production factory is under construction, and the plan is to begin production in the second half of 1995.

In Taiwan, Unipac Optoelectronics Corp.[Note 1)] has begun mass production of a small scale color TFT LCD panel that is said to be somewhere between a four-inch and a six-inch model. A mass production factory for 10-inch class color TFT LCD panels is also under construction. In addition to this, there is one other company aiming for the beginning of mass production in 1996, and has set out to construct a mass production plant.

Toward the Next Generation of Basic Industries

Korea and Taiwan. Both countries share the goal of mass producing TFT LCD panels, in particular, 10-inch class color TFT LCD panels for personal computers. However, when asking, "Why TFT LCD panels?" the ulterior motives are slightly different for the two countries.

For large-scale Korean electronics manufacturers like Samsung Electronics and Kimsung Corporation, the semiconductor business centers on memory and comprises an indispensable basic industry. Semiconductor products also make up a glamour export industry that attracts enormous amounts of foreign capital to Korea.

The big player Korean manufacturers are looking to the rapidly growing world of color TFT LCD panels as the business that will carry the burden of being the product "that will follow the semiconductor." Over the next few years, the production of TFT LCD panels will continue growth at a pace that exceeds 100 percent. Moreover, the supply of such devices is currently the near monopoly of Japan. The Korean manufacturers have decided that now is the time to jump in.

However, there is hardly any demand for color TFT LCD panels within Korea. The reason for this is that laptop personal computers are the greatest supply points, and these are being produced only on a small scale in Korea (Figure 2). Thus, even if color TFT LCD panels are mass produced, the numbers shipped within Korea will not exceed about 20 percent of the total amount of production (Figure 3). The panels, then, will comprise a typical export industry.

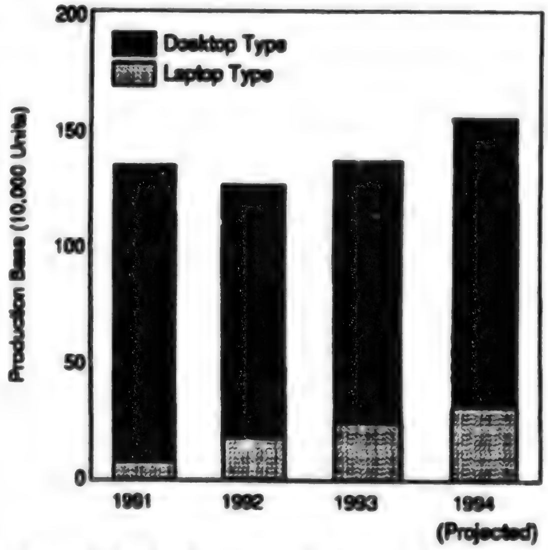


Figure 2. Production Base of Personal Computers in Korea: The percentage of laptops is low. There is no lack of Color TFT LCD panels for the big users. 1994 is a projected value. Based on data from Kimsung Co.

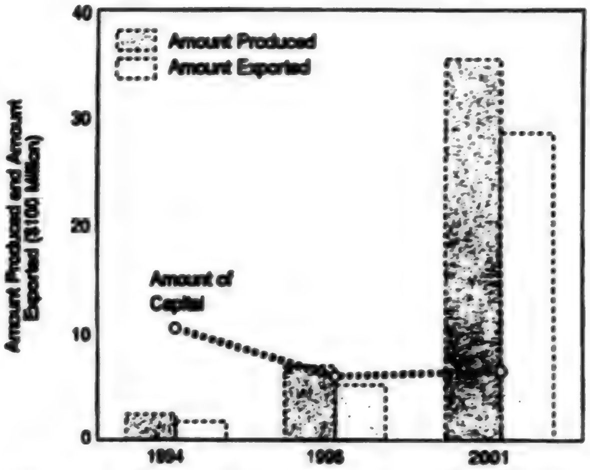


Figure 3. Nearly all the panels, for which projected figures are available regarding the amounts of LCD panel production, export and investment within Korean, will be exported. This projection was made by the Korean Industrial Research Lab.

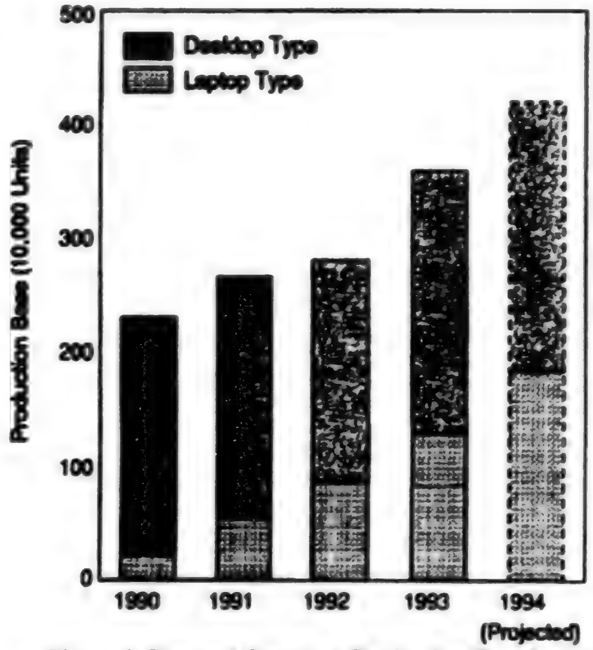


Figure 4. Personal Computer Production Base in Taiwan. The 1993 personal computer production base rose by 3.58 million units, and this occupies a 28 percent share worldwide. Of these, one-third are laptops (including notebook and sub-notebook types), and the laptop type has reached a 50 percent share worldwide. The numbers were collated by the Taiwan Society for the Promotion of Industrial Investment. The Society has projected the 1994 values.

Aiming at Domestic Production of Personal Computer Components

On the other hand, Taiwan is avidly developing color TFT LCD panels with the idea of wanting to be self-sufficient in the components indispensable to the production of personal computers, which is currently a core industry for them.

There is a great demand within Taiwan (Figure 4). Yet, how this demand will be fulfilled is a critical question for the Taiwanese industry. Were the supply of TFT LCD panels from Japan to cease, then the personal computer industry of Taiwan would be dealt a severe blow. This kind of anxiety is driving Taiwan to the production of TFT LCD panels.

"The percentage of notebook personal computers is increasing, and among these, there is noticeable growth in the device types which have color TFT LCD panels mounted. The day is coming when it will not be possible to make personal computers without color TFT LCD panels. It is becoming important that color TFT LCD panels be procured when necessary, in the quantities necessary, and at a suitable price. 'Timing' itself is the absolute condition for success in the personal computer business. That alone is cause for worry about 100 percent dependence upon Japan for the supply of color TFT LCD panels. We personal computer manufacturers are anxiously awaiting for the making of color TFT LCD panels in Taiwan to come one day earlier." (Hiroki Denno)

Suddenly TFT LCD Panels Are the Odds on Winner

Korea and Taiwan are rushing headlong into the domestic production of TFT LCD panels. However, neither country has had notable success in the LCD business. There are manufacturers who have publicly announced the beginning of production for STN (super twisted nematic) system LCD panels, but there does not yet appear to be the capacity to mass produce large-scale panels for personal computers. Those responsible for the on-site management of Japanese manufacturers supplying STN LCD panels for Korean and Taiwanese personal computer manufacturers say that "even if there has been competition among Japanese manufacturers, there has not been any competition from the manufacturers here."

The odds on winner is the TFT LCD panel. Both countries will leap into the most recent TFT LCD panel technologies in a single bound, bypassing STN LCD panels, which have become a mature technology. Most Japanese manufacturers have been promoting the development of TFT liquid crystals while fine tuning the technology for the mass production of STN LCD panels. For Korea and Taiwan, this is entry into the business at a time when the flower has finally just begun to bloom.

"Clearly, Korea and Taiwan pose a formidable threat. Although we took the pains to raise it up from the seed,

the fruit that has finally come will not be harvested before it is split into thirds." (A Japanese LCD panel manufacturer)

TFT LCD Panels Cannot Be Procured

The sense of danger is growing among Japanese manufacturers. There also appears to be manufacturers who, fearing a technology drain to Korea and Taiwan, have a policy of withholding the supply of the newest color TFT LCD panels.

Some Korean personal computer manufacturers are having difficulty getting color TFT LCD panels. Not only panels, but they are not able to procure color filters and liquid crystal drive ICs either. This is also the state of affairs for Japan. There is insufficient supply of color TFT LCD panels and color filters.

"If you're selling the same thing, it's only natural that before too long the customer with whom you are most familiar will have the priority." (A business director in a Korean branch of a Japanese trade company.) Korean manufacturers, who are struggling to develop mass production, are not yet "priority customers." There are also Korean manufacturers who interpret this as the harassment of Japanese manufacturers. "We would like to have fair competition." (An executive of Samsung Electronics)

Just as with their difficulty in procuring parts, the attempts of Korean manufacturers at acquiring technology from Japan have currently ended in discord. Samsung Electronics and Kimsung Corporation have applied for technical cooperation from numerous Japanese manufacturers. However, there does not appear to be any Japanese manufacturers who will respond. "Irrespective of STN LCD panels, for which the market has already matured, there is nothing compelling Japanese manufacturers to cooperate with foreign manufacturers in TFT LCD panel technology, which is the technology that holds the future. To establish technical cooperation first requires benefits for both sides. Even if we cooperate with Korean manufacturers and lose nothing, we have nothing to gain." (A Japanese LCD panel manufacturer)

Technology Is Being Drained Along With the Devices

One reason that Korean manufacturers are having trouble getting cooperation from Japanese manufacturers is the problem of patents. Many Japanese manufacturers have delivered statements warning of patent infringement for LCD panel technology to Samsung Electronics and Kimsung Corporation. Currently, no great battle has developed because there has only been small scale production. However, when Korean manufacturers enter into a genuine mass production system, there will be a big face-off over patent violations.

"They should not be able to avoid all the patents of Japanese manufacturers. In particular, even if Korea mass produces TFT LCD panels, nearly all of them will have to be exported. They will then be subject not only to the patents established in Korea, but also subject to infringement of patents in such export destinations as the United States." (A Japanese LCD panel manufacturer)

However, it will probably be difficult to stem the drain of the technology using patents. Many of the Japanese LCD panel manufacturers are indicating that "unless the LCD panel production device manufacturers stop supplying devices to Korea and Taiwan, we will not be able to stem the drain of technology." LCD panel manufacturers are developing devices while building close ties with production equipment manufacturers. Naturally, a lot of know-how goes along with production equipment. If this equipment is handed over to Korea and Taiwan, that technology will also be drained along with it.

Continuing to Chase After the Leader

"Sooner or later, the day will probably come when Korean and Taiwanese manufacturers are mass producing color TFT LCD panels. There is no way to stop that. The problem, then, is what the Japanese manufacturers will do at that time." (A Japanese LCD panel manufacturer)

If Korea and Taiwan catch up, Japanese manufacturers will have to move further ahead. By continuing to chase after the lead, they will create new technologies which in turn will be subject to technology drain (Figure 5 [figure not reproduced]). Unless they do this, Japanese manufacturers will not be able to maintain their edge.

"For example, at our company we are tackling the improvement of image quality in LCD panels. First, we realized a full color display, and then developed a technology to broaden the visual angle. If we are negligent in these efforts, Korea and Taiwan will immediately gain on us." (A Japanese LCD panel manufacturer)

In addition to tackling the high image quality and low cost amorphous Si TFT LCD panels that are currently being mass produced, Japanese manufacturers are also making progress in the development of polycrystal Si TFT LCD panels. As long as there is the "next" kind of device, the others catching up can be avoided. However, the moment that there is no "next" in sight, Japanese manufacturers will be standing at the edge of a precipice.

Part 2. Technical Issues and the Current State of Development

On the verge of mass production, the next issue will be the reduction of costs.

Korean manufacturers are developing color TFT LCD panels, and have the lead over Taiwanese manufacturers. Samsung Electronics has already completed prototyping a 12-inch model. This company has begun production of a 10-inch class panel on a scale of approximately 800 panels per month. Kimsung Corporation has also completed prototyping a 10-inch model panel. The problem for them is to move into mass production, and the difficulty will be in keeping costs down. It will be

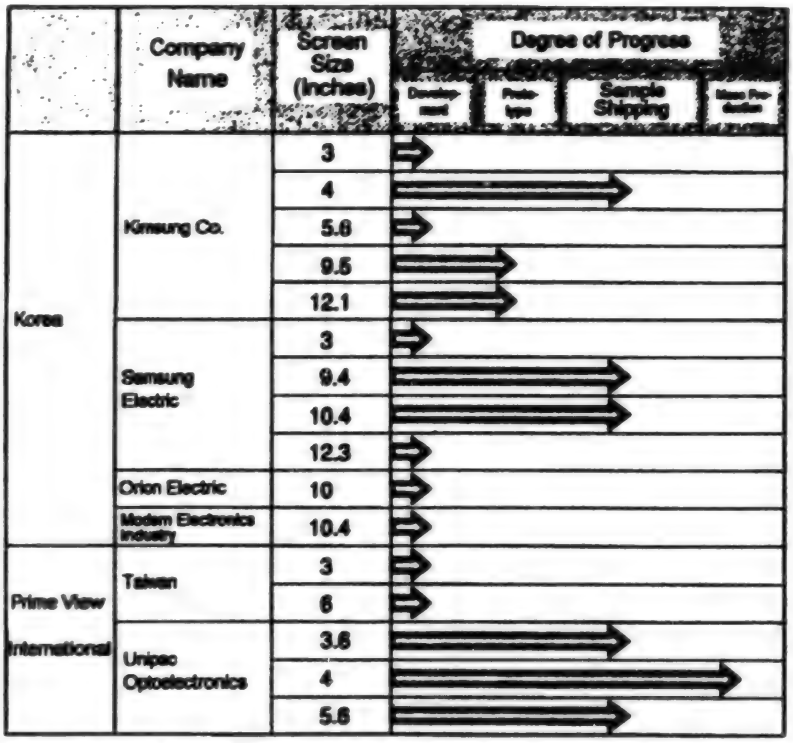


Figure 2. Korean and Taiwanese manufacturers who mass produce color TFT LCD panels. In addition, two other Taiwanese corporations, Hekiyu [Japanese pronunciation] Electric and Nana Soko [Japanese pronunciation] Industries, have announced entry in color TFT LCD panels. This table was drafted by Nikkei Electronics based on information from the Korean Industrial Technology Lab.

necessary for them to improve yields. On the other hand Taiwanese manufacturers are at the beginning stages of prototypes and small scale production of small scale panels. They are taking the risks of entering the mass production of large-scale panels all at once.

"I think they can do it if they get the equipment. However, I doubt that they really will be able to." (Figure 1 [figure not reproduced].) Many Japanese manufacturers have raised doubts about the mass production plans for color TFT LCD panels being launched by Korean and Taiwanese manufacturers.

Samsung Electronics and Kimsung Company in Korea and Unipac Optoelectronics Corporation and Prime View Int. Co., Ltd.[Note 2)] in Taiwan have already begun constructing plant facilities to mass produce 10-inch class color TFT LCD panels (Figure 2). The die has been cast. There is no turning back.

However, compared to the way that Japanese manufacturers do things, it cannot be said that Korea and Taiwan have embarked on mass production in a systematic manner. The approach of Japanese manufacturers is to first produce a small three-inch model panel on a small scale. While repeatedly testing by trial and error, know-how for mass production technology is accumulated. In parallel with this, progress is made in the development of large-scale panels. Once they are fully familiar with the technological capacity, they begin construction of large-scale plants to mass produce large-scale panels. Their approach is to gradually increase the size of the panel and the scale of the plant while building on previous stages.

For example, Sharp began mass production of three-inch color TFT LCD panels in 1987, and they began mass production of 10-inch class panels in 1990. While gradually increasing the scale of the first plant, they began constructing a mass production plant having the productive capacity of 150,000 panels per month. Compared to this, the rapid journey Korean and Taiwanese manufacturers are traveling from development to mass production has been ridiculed by Japanese manufacturers as being "like getting out of grammar school and then suddenly becoming a citizen."

Samsung and Kimsung Have the Lead in Development

With this said, Samsung Electronics and Kimsung Corporation of Korea are the ones that have tackled the development of color TFT LCD panels comparatively quickly. Samsung Electronics completed development of a color TFT LCD panel for a 10.4-inch model personal computer in 1992, and they also began testing a 12.3-inch panel (Figure 3 [figure not reproduced]).

They started production of the 10.4-inch model using a small scale plant. Approximately 2500 panels (converted to 10-inch models, the same applies below) per month were attempted on a pilot line, and about 800 panels were produced. Some of the finished products were mounted into the personal computers, etc. produced by Samsung.

The Yanayama [Japanese pronunciation] plant, which will be Samsung's first color TFT LCD panel mass production plant, is currently under construction within the Kiko [Japanese pronunciation] plant,[Note 3)] which is the main semiconductor plant of Samsung. The building will be completed in the fall of 1994, and mass production will start from the first part of 1995. The productivity in terms of the number of panels attempted in the first generation line is expected to be about 40,000 panels per month. After this, enhancement of the facility will continue, and in 1998 it will have the capacity to attempt about 200,000 panels per month. The total amount of investment in the new plant will be approximately ¥35 billion. In order to strengthen the plant to 200,000 panels per month production, an additional ¥15 billion will be invested.

Kimsung Corporation has also completed a prototype of a 10-inch class panel (Figure 4 [figure not reproduced]). Currently they are producing four-inch class small-scale panels on a pilot line at a scale of approximately 6,000 panels per month, and they have begun shipping samples. The yield averages about 60 percent.

A mass production plant is under construction at Gumi, near Seoul. The buildings will be complete at the end of 1994, and production will begin at the end of 1995. The productive capacity will be 40,000 panels per month. A total of about ¥40 billion will be invested. There will be a second round of investment one year after the beginning of production, and the productive capacity will be expanded to 80,000 panels per month.

Uncertainty About the Panel Assembly Process

The construction of plants for mass production is making orderly progress. The selection of production equipment is also nearly finished. All that remains is to start up the plant.

Regarding the production equipment, the Korean manufacturers will also be introducing the same kind of so-called "second generation line"[Note 4)] equipment which Sharp, Display Technology, and NEC, etc. began operating in 1994. It is expected that the dimensions of the substrate will be 370 x 470mm^2 for Kimsung Corporation, and 360 x 465mm^2 for Samsung Electronics. This corresponds to the 360 x 465mm^2, which can yield four 9-inch panels, adopted by all Japanese manufacturers on their second generation lines. However, Samsung Electronics says, "when taking four 9-inch panels from 360 x 465mm^2, it is a little cramped. We are still studying the use of a substrate that is a little bigger."

"We have confidence in the process of making TFT panels. The technology which has been cultivated with semiconductors is thriving in this process. We are not worried. If we have any doubts at all, it is probably in the assembly process of the panels. However, we will worry when we hear of a specific problem somewhere. Because we have heard that 'the assembly process is difficult,' we have just thought that 'it will probably be difficult.' Actually, we must engage in mass production to see how difficult it is." (Samsung Electronics)

Concern for Cost Reduction

Seen one way, the challenge from Korean manufacturers can be seen as progressing in an orderly way. However, hidden problems are mounting. First, there is the problem of operating the equipment once it has been set up. Japanese manufacturers indicate that "Even if you buy the equipment, it is difficult to master it. Buying general use equipment does not mean it will be rapidly mastered."

Once the equipment works, next there is the problem of how to reduce costs. In order to compete with the Japanese manufacturers of LCD panels who have a head start, it is necessary to deliver to the market color TFT LCD panels that cost less than the panels manufactured by the Japanese. This is difficult.

On the surface, Korean manufacturers can procure almost all the raw materials for producing color TFT LCD panels from foreign manufacturers such as the Japanese. This is also the same for production equipment. They cannot compete with Japanese manufacturers by reducing parts and materials expenses, or facilities depreciation costs.

Korean manufacturers have an advantage in labor costs. However, the percentage that labor costs occupy in the cost of producing color TFT LCD panels is low. "When viewed from the first generation mass production lines which are currently operating, the percentage of the depreciation costs and parts and materials costs of the equipment occupies about 75 percent of costs. The percentage that labor costs hold only about 25 percent. Furthermore, when the second generation lines come on line, the percentage labor costs will probably be half or less that of the first generation lines because of advanced automation" (Executive in charge of LCD panels at NEC). Competing with Japanese manufacturers using the weapons of low labor wages will probably yield little fruit.

Consequently, it is necessary to improve yield. It is the accumulation of production know-how that dominates yields. "First, it is necessary to master the equipment. Even if the equipment that has been purchased is used as is, the yields will not rise. There are many parts which must be improved during a hands-on process. It will take some time until this is done. Next, there are countermeasures for poor product. Effective countermeasures for

poor product cannot be taken unless there is the experience of asking how is this the same as poor product that was put out in the past, and how was it dealt with at that time." (Party in charge of Production Technology at the Taiwan Aifu [phonetic] Production Industries (local corporation of Seiko-Epson)).

Taiwan From "Out of the Blue"

In terms of lack of experience, Taiwanese manufacturers have an even worse record than Korean manufacturers. Unipac Optoelectronics Corporation which began production of 3.6-inch and 5.6-inch small-scale color TFT LCD panels in Taiwan boast that, "We have made greater progress than Korea. We were first after Japan to succeed in mass production of color TFT LCD panels. Korean manufacturers are still in the prototyping stage. They have not yet reached the stage of mass production and marketing."

However, the panels currently being produced are nonetheless small scale. The scale of production is also small (Figure 5, Figure 6 [figures not reproduced].) The production capacity in terms of panels attempted is 10,000 panels per month, converted to four-inch models. Currently about 5,000 panels per month are being shipped. For Korean manufacturers, this would be a scale equivalent to a pilot line.

They have not yet reached even the prototyping stage in terms of 10-inch class panels. However, they are already pressing plans for mass production. They will begin construction of a mass production plant in 1994 that will be capable of making 20,000 300x400mm^2 glass substrates-Note 5) per month. In this factory, the plan is to produce 10-inch class panels. Converted to 10-inch models, the plant will have a production capacity of 40,000 panels per month. This would be the same scale as the mass production plants of the Korean manufacturers.

Among the other Taiwanese manufacturers, Prime View International Co. Ltd. has begun construction of a mass production plant for color TFT LCD panels. The plan is to begin mass production in the spring of 1996. About ¥14 billion will be invested, and about 24,000 panels per month will be made, converted to terms of 10-inch models. 360 x 465mm^2 glass substrate will be used.Note 6)

Currently, this company has three-inch and six-inch color TFT LCD panels under development (Figure 7, Figure 8 [figures not reproduced].) They have not yet started mass production. Large-scale 10-inch class panels will be developed from here. Naturally, development must be finished and studies of mass production must be completed by 1996 when the mass production plants for large-scale panels will be completed. Judging from the progress of Japanese manufacturers, this is an unbelievable speed at which to suddenly progress into mass production.

Aiming at Internal Production of Parts

"There are many problems. We are most worried about the yield. Only Japan has the production technology for 10-inch class color TFT LCD panels. We must make a corresponding effort to catch up with this" (Prime View International Co. Ltd.). Other Taiwanese manufacturers also agree that the road ahead is not smooth. The first premise is that they can make them, but even after making them, they know that severe competition with Japanese manufacturers awaits them.

"In order to compete with Japanese manufacturers, we would first like to appeal to Taiwanese users who can give technical support within Taiwan itself. We can step up delivery periods, and we can convey new product information quickly to the users. The most important factor is price. First, it is important to improve yield. In addition, we would like to reduce costs by producing domestically the parts and source materials that are currently being purchased from Japan" (Unipac Optoelectronics Company, Figure 9 [figure not reproduced]).

This company plans on reducing costs by producing color filters, drive ICs, and back lights domestically. Prime View International also plans on producing color filters and drive ICs domestically.

Korean manufacturers are also making progress in strengthening internal production of parts and source materials. "Color filters are particularly expensive. Moreover, they are hard to get a hold of. Japanese manufacturers first sell to Sharp and NEC, etc., and they will only sell what is left over to us" (Samsung Electronics).

Only Time Is Needed

Korean and Taiwanese manufacturers have their own reasons for wanting to mass produce color TFT LCD panels. What they have in common is that the manufacturers from both countries sincerely feel that "If we do not make TFT LCD panels ourselves, there will be no future." "TFT LCD panels are a key device of the future. If we rely on the supply of these from abroad, then we will not be able to produce parts that are advanced and competitive" (Kimsung Company).

What the Korean and Taiwanese manufacturers are afraid of is that they will not be able to obtain color TFT LCD panels when they want them, and that a situation may arise in which no one will sell them advanced color TFT LCD panels at all. This kind of experience has actually happened to them in the past, as many manufacturers will point out.

If it is difficult to get a hold of color TFT LCD panels, then they had better make them themselves. If it becomes difficult to acquire the parts and materials for them, then they will just have to produce the parts and materials themselves. This is how Korean and Taiwanese manufacturers are feeling, and the same could be said of Japanese manufacturers.

"We have investment capital. If there is capital, then we can gather the human resources. We can buy equipment

and build factories. We also have an inexpensive labor force for operating the plant" (Prime View International Corporation).

Of course, they have more than enough determination to do it. All they lack is experience and know-how. This too is probably a matter of time. The day when color TFT LCD panels is no longer the unique product of Japan is not that far off in the future.

Footnotes

Note 1) Prime View International Co., Ltd. A financial group called the Eihoyo Group, which is centered in the Seishi Co. of Taiwan, financed and established this company in 1992 for the purpose of developing and mass producing color TFT LCD panels. It has a research and development center in the Science Industrial Park section which is in Niitake City.

Note 2) Unipac Optoelectronics Corp. is one of the major semiconductor manufacturers in Taiwan, and is the only manufacturer of TFT LCD panels. It was financed and established by UMT, and its principle product is TFT LCD panels. They have a mass production plant for TFT LCD panels in the Science Industrial Park section which is in Niitake [Japanese pronunciation] City, Taiwan.

Note 3) This Kiko [Japanese pronunciation] Plant is the main semiconductor plant of Samsung Electronics. The arrow (on the right of the photograph) indicates the research and development building which houses the pilot line for color TFT LCD panels. The Yanayama Plant, which will be a mass production plant for color TFT LCD panels, is currently being constructed to the right of this building. The company responsible for construction also belongs to this same Samsung Group.

Note 4) The second generation line of Japanese manufacturers will begin operation within 1994. The substrate dimensions have become larger compared to the first generation lines, which used substrates of about 300 x 400 mm^2. Companies like Sharp have adopted 360 x 465 mm^2 substrate, which is called the giant of the industry world. However, manufacturers like Fujitsu who will introduce new equipment in the future, and will set off to introduce a round of substrates even larger than 360 x 465 mm^2.

Note 5) The same dimensions for glass substrate that Japanese manufacturers introduced in their first generation lines.

Note 6) The same dimensions for glass substrate that Japanese manufacturers will introduce in their second generation lines.

EA, MHW Announce Policy for FY95

95FE0053A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 8 Sep 94 p 6

[FBIS Translated Text]

Environmental Agency

For FY95, the Environmental Agency (EA) requested a research-related budget totaling ¥13.001 billion, a 10.1 percent increase over the FY94 figure.

Global Environment

EA's budget request for the global environmental research general promotion fund was ¥2.550 billion, ¥250 million more than the FY94 amount. The fund is used for the overall support of interdisciplinary, interministerial, and international research projects concerning global environmental preservation, which are being carried out by leading researchers in a variety of fields. The target fields of these projects include (1) destruction of the ozone layer, (2) the global warming trend, and (3) acid rain.

EA added a new project of international exchange research (with an outlay of ¥150 million) to carry out cooperative research projects by inviting top-class researchers from overseas for promoting global environmental research. EA also requested ¥2 billion, ¥286 million more than the FY94 amount, for operating the Global Environmental Research Center in order to cover its expanded activities, including the analysis of data obtained by a satellite to be launched in February 1996 and supercomputer-related research activities.

Local Environment

EA requested ¥74 million, an increase of ¥49 million over the FY94 level, for local close-cooperation research projects that have, since FY93, been promoted under the cooperative research system. Under this system, national research institutes and experiment stations which have accumulated expert knowledge and sophisticated technology are to work closely with local research groups which are affiliated with public governments and are experienced and knowledgeable in local environmental preservation policies.

New Policies

EA is also proposing new projects for FY95. These include a survey project for promoting a basic environmental plan (¥200 million), survey research concerning a recycling system for a circulating society (¥35 million), and a survey concerning cooperative enforcement of anti-global warming trend policies (¥18 million). EA also plans to carry out basic surveys to assist developing countries in fighting air pollution (¥65 million).

Ministry of Health and Welfare

The Ministry of Health and Welfare (MHW) is currently holding a health and welfare science conference to review its priority research fields. It appears that MHW will soon establish the Health & Welfare Science Special Research Fund for pioneering and interdisciplinary fields, and in FY95, MHW plans to start a feasibility study (FS) for the Fund with a requested budget of ¥50 billion. MHW's new research titles are given below.

Elucidation of Brain Functions

MHW is aiming at overcoming psychiatric and neural diseases by studying life phenomena of the cerebro-neural system from all angles, hopefully to impact social science fields with study results. For instance, in the hardware area, attempts will be made to develop a high-efficiency memory device using biotechnological chips, an information management system using a neuro-computer, and a fully automated production system through sophisticated simulation capability. In the software area, efforts will be made to vitalize potential capabilities and develop a non-language communication method. MHW is requesting ¥50 million for a one-year FS for the brain function elucidation project.

MHW plans to carry out an information technology development project to evaluate software products to be used in the medical field and the type of medical information to be disseminated. The Ministry of Posts and Telecommunications is also participating in this project by developing key technology for information management.

MHW also plans to define research project titles and a system that will be necessary for improving health care service, including that for senior citizens. MHW is also asking for ¥50 million for a one-year FS for these potential projects.

General Research Fund for Long-Term, Chronic Diseases

MHW is requesting a sum of ¥520 million for this fund. MHW plans to reorganize its research groups so that each of such diseases as kidney malfunction, diabetes, rheumatism, allergies, and circulatory system disease will be studied not by one research group, as has been done previously, but by newly organized research groups involving diagnosis, pathology, symptom, treatment, immunology, and quality-of-life.

Agency for Cultural Affairs Establishes Central Management Subcommittee to Review Copyright Management

95FE0053B Tokyo DEMPA SHIMBUN in Japanese 5 Aug 94 p 2

[FBIS Translated Text] On 4 August 1994, the Agency for Cultural Affairs organized the Central Copyright Management Subcommittee within the Copyright Council for the purpose of reviewing future copyright management policies to cope with anticipated dramatic changes in the usage of copyrighted materials as a result of the advancement of multimedia systems. The subcommittee held its first meeting on the same day.

This subcommittee is made up of 21 members, including scholars and individuals from applied areas, as well as

individuals affiliated with various organizations. The subcommittee expects to conclude its deliberation in 18 to 24 months.

Today, there is a copyright management system for musical compositions, novels, and screenplays. This system is used by the Japan Music Copyright Association and the Japan Literary Copyright Protection Alliance based on the copyright intermediary law. However, since its enactment in 1939, this law had essentially remained unchanged. Therefore, copyrighters began to suggest that the targets of this law be "reexamined."

At the same time, performing and recording artists, including singers and actors and actresses, are managing, through organizations designated by the Japan Performing Artist Conference and the Japan Recording Association, via copyright law, the right to claim fees for the secondary use in broadcast and remuneration for rentals. In addition, copyrighters have arbitrarily organized the Japan Copyright Center to deal with the business of issuing copyright permission and the signing of contracts in the fields of literature, fine arts and photography.

The subcommittee plans to reexamine copyright management, including the expansion of the designated organization system, because it can be anticipated that problematical situations will arise for both copyrighters and users as a result of increased complication in copyright handling, especially when a copyrighter chooses not to join an organization and when multimedia systems advance further.

Spotlight on Japan Society for the Promotion of Machine Industry

95P60082 Tokyo KIKAI SHINKO in Japanese Dec 94 p 1

[FBIS Media Note] The Japan Society for the Promotion of Machine Industry (Kikai Shinko Kyokai) is a non-profit organization under the administration of the Ministry of International Trade and Industry (MITI). The Society serves Japan's machinery industry by surveying developments in foreign and domestic technology, providing a forum for government and corporate views on various industry issues, providing technical services, and helping Japanese companies train personnel.

The Society at a Glance

The Society, a nonprofit foundation (zaidan hojin) established in 1964, falls under MITI's Machinery and Information Industries Bureau (MIIB). Its goal is to "contribute to Japan's machinery industry" by working to upgrade related technology and improve management practices, according to an annual guide of MITI's nonprofit organizations. Specific activities include studying management practices, gathering relevant economic information, and surveying industrial technology (TSUSHO SANGYO SHO KANKEI KOEKI HOJIN BENRAN 1994 Mar 94).

The organization is well connected to Japan's business and government circles. Chairman Shoichiro Toyoda is also chairman of Toyota Motor Corp. and the Keidanren corporate federation. Masaru Sugiura, a deputy chairman and chief of the Society's research institute, is a former chief of MITI's Agency of Industrial Science and Technology (AIST). Yoseki Nagase, another Society deputy chairman and chief of its economic institute, formerly headed the Economic Planning Agency's Coordination Bureau. Shigeru Ueno, the deputy chief for the Society's Manufacturing Technology Division, has held executive positions in the International Robotics and Factory Automation Center (IROFA) and the Japan Machine Tool Builders' Association (JMBTA). MITI's MIIB administers those two nonprofit organizations as well (TSUSHO SANGYOSHO KANKEI KOEKI HOJIN BENRAN 1994 Mar 94, NICHIGAI-ASSIST*WHO Jan 95).

Disseminating Information

The Society surveys foreign and Japanese technology and economic trends. It conducts its activities both jointly and on contract with MITI and Japanese industry (KIKAI SHINKO).

The organization also publishes several journals as part of its mission to survey industry developments and disseminate the information to Japanese readers. The Society's economic research institute publishes KSK SCANNER, a journal covering foreign industry developments. The organization's technology institute publishes several technology newsletters: GIKEN NEWS, GIKENJO HO, and KAKO GIJUTSU DATA FILE (KIKAI SHINKO Jan 95).

KIKAI SHINKO, a monthly journal, reflects the Society's close relations with MITI and corporate Japan. Funds from MITI-sanctioned gambling on bicycle races subsidize the publication. Most issues feature representatives from government, nonprofit organs, and corporations addressing an industry topic in a roundtable discussion. The journal has recently covered Japan's emerging space industry, new trends in software, and the future of the nation's aircraft industry (KIKAI SHINKO Sep, Oct, Nov 94).

In KIKAI SHINKO's October 1994 software issue, for example, an official of MIIB's Data-Processing Promotion Division chaired a roundtable discussion including directors from three MIIB non-profit organs related to the computer industry, a Nippon Telegraph and Telephone Corp. (NTT) affiliate, and a university professor. The roundtable offers a concrete example of the government-industry-academic approach MITI takes to industrial technology issues. The rest of the issue consists of articles by other MITI, corporate, and academic experts.

The Society also helps spread information throughout industry by providing a forum for meetings. The organization hosts conferences at its Kikai Shinko Kaikan hall. For example, it is holding one in late February 1995 on recent improvements in machining technology (NIHON KOGYO SHIMBUN 9 Jan 95). The Society also rents the hall's conference rooms to other organizations. It also operates its own club (KIKAI SHINKO Jan 95).

Providing Technical Services, Training Personnel

The Society's technology institute aids Japanese industry by offering technical services. Its services include testing

interoperability between MAP (manufacturing automation protocol) and numerically controlled (NC) machining systems and conducting tests and analysis for precision machining and calibration (KIKAI SHINKO Jan 95).

The Society also runs a facility on the Izu peninsula that serves as a training center and retreat for member executives. The Izu Training Institute includes both classrooms and recreational facilities (KIKAI SHINKO Jan 95).

Recent Events

December 1994: Society Deputy Chairman Masaru Sugiura chaired a committee to choose companies to receive subsidies from the MITI-administered New Energy and Industrial Technology Organization (NEDO). Sugiura's committee selected 10 companies from among 70 applicants for the NEDO funds to subsidize as much as two-thirds of the R&D costs for companies developing innovative industrial technology (NIKKAN KOGYO SHIMBUN 2 Dec 94). [For more information on NEDO's R&D subsidy program, see S&T Perspectives Vol 10 No 1, 31 Jan 1995]

October 1994: The Society held its 29th annual awards ceremony for achievement in industrial technology. Twelve companies and research organizations among the 55 nominated by industry associations received awards (NIKKAN KOGYO SHIMBUN 8 Oct 94).

MITI Expands ISTF System Program

95P60106 Tokyo NIHON KOGYO SHIMBUN in Japanese 23 Jan 95 pp 2-3

[FBIS Media Note] Japanese media over the past month have reported details of the technology development policy adopted by Ministry of International Trade and Industry (MITI) for FY95. The government proposal for MITI's FY95 R&D-related budget is approximately ¥297.1 billion ($2.97 billion), a 4.3 percent increase compared to the initial FY94 budget. Within this budget about ¥62 billion ($620 million) has been allocated for S&T promotion, a 3.4 percent increase. The budget allocation appears intended to encourage new industries and reflects the emphasis of Prime Minister Murayama's administration on development of basic research and technology and the research infrastructure (NIKKEI SANGYO SHIMBUN; DENKI SHIMBUN 10 Jan 95).

MITI's science and technology policy emphasizes three objectives: 1) to establish research and development infrastructure; 2) to promote research and development projects; and 3) to promote a comprehensive policy to cultivate fundamental technologies that could lead to new projects (NIKKEI SANGYO SHIMBUN; DENKI SHIMBUN 10 Jan 95).

The core of MITI's policy is the Industrial Science and Technology Frontier Program (ISTF) System. MITI's Agency of Industrial Science and Technology (AIST) established the ISTF system in 1993 by combining three previously established R&D programs: the National Research and Development Program (large-scale projects), established in FY66; the Research and Development Project of Basic Technologies for Future Industries (next-generation projects), established in FY81; and the Medical and Welfare Equipment Technology Development Program, established in FY76. The ISTF System was intended to improve the R&D environment, utilize and share research results widely, and deal with the increasingly blurred distinction between technical application and basic science (NIHON KOGYO SHIMBUN 23 Jan 95). (For previous reporting, see the FBIS Foreign Media Note "Japan: Overview of MITI's Industrial Technology R&D System," FB PN 93-366, 26 Aug 93.)

MITI promotes R&D for industrial science and technology through a program of close cooperation between the industrial sector and academic societies in Japan and abroad. ISTF aims to promote 1) innovative basic research and development that will lead to socially and economically beneficial technological breakthroughs; and 2) research that will improve living standards, ensure resource supply, or establish an infrastructure to promote science and technology (NIHON KOGYO SHIMBUN 23 Jan 95).

MITI allocated approximately ¥24.9 billion ($249 million) for the FY95 ISTF system program, a 5.4 percent increase compared to FY94. MITI supports advanced research that is difficult to directly apply technically to projects. MITI conducts preliminary studies to determine whether a subject is suitable to become a large project (NIHON KOGYO SHIMBUN 23 Jan 95).

In FY94, MITI chose five new advanced technology research subjects under the ISTF System: 1) Precision-polymerized materials (FY94 budget: ¥45 million); 2) accelerated evolution of biological functions (¥40 million); 3) human media (¥50 million); 4) next-generation metal resources technology (metal revolution) (¥40 million); and 5) product evaluation and advanced measurement/analysis technology (¥40 million) (NIHON KOGYO SHIMBUN 23 Jan 95, KOGYO GTJUTSUIN KENKYUJO KENKYU KEIKAKU 1994, MITI HANDBOOK 1994).

MITI added six new subjects to its advanced technology research for FY95: 1) molecular coordination materials; 2) super metals; 3) brain-function information processing (brain-ware); 4) cell growth control technology; 5) photonic technology; and 6) intelligent structural systems (NIHON KOGYO SHIMBUN 23 Jan 95). The average budget for each subject is about ¥50 million ($500,000). Once a subject is selected for the ISTF System, however, its budget is drastically increased.

The following are the descriptions of each subject:

1) Molecular Coordination Materials

Goal: To study basic and fundamental technology related to applications, manifestation, and creation of new organic materials formed by cooperative interaction among organic molecules, metals, and inorganic materials in living body tissues.

2) Super Metals

Goal: To create materials (super metals) with superior characteristics by developing new processing technology and production methods.

3) Brain-Function Information Processing (Brain-ware)

Goal: To develop new information processing systems and devices by studying information processing functions of brains from both engineering and information science points of view and applying the results.

4) Cell Growth Control Technology

Goal: To analyze changes in cell growth over time, develop means of controlling the process, and create engineering applications.

5) Photonic Technology

Goal: To promote basic analysis of physical and chemical developments in photonic systems and materials research. At the same time, to develop application technologies and related technologies of photon generation and control.

6) Intelligent Structural Systems

Goal: To integrate materials that have sensing and actuating functions with structural materials in order to develop technology able to measure its own reliability, to detect its faults, and to make decisions.

(NIHON KOGYO SHTMBUN 23 Jan 95)

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